INSTRUCTION MANUAL

DIFFERENTIAL ADMITTANCE ADAPTER

MODEL 100-PA-100S

DRANETZ
ENGINEERING
LABORATORIES
INCORPORATED

1233 NORTH AVENUE, PLAINFIELD, N. J. 07062 • TEL. (201) 755-7080

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SECTION I

OPERATION

1-1 FUNCTIONS OF CONTROLS AND TERMINALS

Table I lists the functions of controls and indicators of Differential Admittance Adapter Model 100-PA-1008.

Table I. FUNCTION OF CONTROLS AND TERMINALS

Control or Terminal	Function
RANGE switch in MICROMHOS 12 Positions: 100, 250, 500, 1K, 2.5K, 5K, 10K, 25K, 50K, 100K, 250K, 500K.	Presets full-scale ranges for admittance. Admittance is indicated in parallel conductance and susceptance.
MODE 3-position switch Y FS - 0	Selects precalibration and operation modes: Y - Admittance FS and 0 - Adjustment for calibration of zero and full scale positions only. Precalibration holds for any amplitude range or admittance.
Y+ terminals	Five-way terminals for connection to device being measured. Low side of terminals are grounded.
Y- terminals	Five-way terminals for connection to device being measured used in conjunction with Y+ input to measure the difference between two admittances. Low side of terminals are grounded.
DIFF - Y+ switch	In the Y+ position, selects a direct measurement of a two-terminal admittance. In the DIFF position, measures the difference between two admittances.
EXT. AMP. connector	* EXT. AMP. connector is provided on the plug-in adapter for measuring higher ranges of admittance & Freq. above 20 kHz.
SIG MONITOR terminal	Provides a monitor point to observe the 30-millivolt signal (a function of the admittance Y).

* Best results are obtained with external amplifier thru cable supplied for direct connection to 100-PA-1008 thru phone jack on front panel.

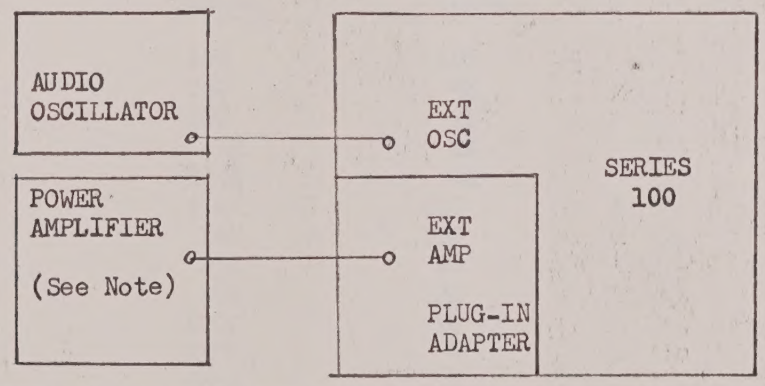
1-2 OPERATING PROCEDURE

a. Remove existing plug-in adapter from the Series 100 Complex Impedance-Admittance Meter and replace with Differential Admittance Adapter Model 100-PA-1008.

NOTE

If plug-in adapter is not installed properly, the LIMIT INDICATOR on the Series 100 will be on when the equipment is energized. Tighten thumb screws on plug-in adapter until LIMIT INDICATOR lamp is off.

b. Connect the equipment as shown in figure 1-1.



NOTE: External Power Amplifier is used for admittance ranges not capable of being driven by the internal emitter follower.

Figure 1-1. Equipment Setup

c. Follow instructions for measuring admittance in Section II of Model 100B or Model 100C Instruction Manual.

NOTE

When performing direct measurement of a two-terminal admittance or a measurement of the difference between two admittances, observe the notes and precautions listed in paragraph 1-3.

1-3 NOTES AND PRECAUTIONS ON THE USE OF THE MODEL 100-PA-1008 ADAPTER

a. The internal Power Emitter Follower drives admittance ranges up to 2.5K umhos when used with the Model 100B only. When used with Model 100C or 100B Mod 4, the internal emitter follower permits admittance ranges up to 25K umhos.

b. An external Power Amplifier is only required for those ranges above those not driven by the internal Power Emitter Follower.

c. NOTE: The external Power Amplifier is required to provide the unit with a 3 volt rms undistorted sine wave. The Power Amplifier is connected to the PWR AMP input of the plug-in adapter. When the external Power Amplifier is not rquired, The External Audio Oscillator is connected to OSC input in Model 100B or 100C.

d. The following load impedances correspond with each admittance range:

Range (umhos)	Load Impedance (ohms)
100	10K
250	4K
500	2K
1K	1K
2.5K	.4K
5.0K	200
10K	100
25K	40
50K	20
100K	10
250K	4
500K	2

Note that if the range is 500K umhos, the load impedance is 2 ohms and requires a Power Amplifier which can provide the required 3 volts rms undistorted sine wave signal. In the same case, if two inputs are usedd(for difference measurements), the load impedance is 1 ohm. For a 250K range, the load impedance is 4 ohms and the same principles apply, and so forth.

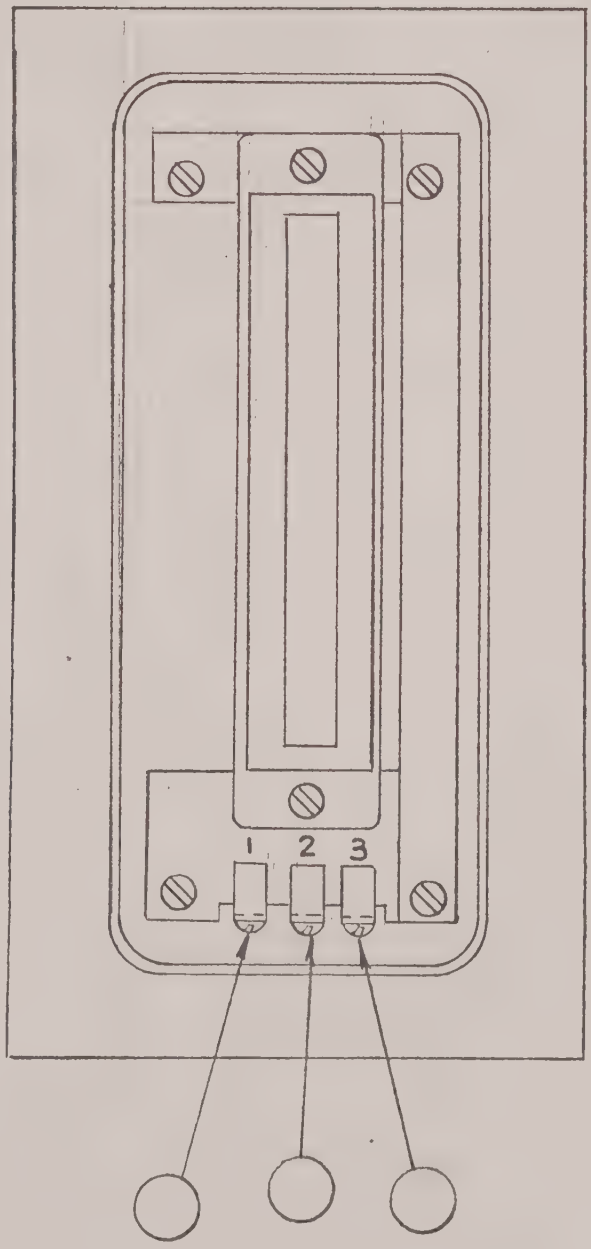
e. An EXT. AMP. input is provided on the adapter for connecting a Power Amplifier. This EXT. AMP. input connector is in addition to the one used on the Series 100 units. The EXT. AMP. connector on the plug-in adapter should always be used for the ranges not covered by the internal Emitter Followers.

CAUTION

The External Power Amplifier should be fused or current limited to a 5 ampere maximum.

f. When performing a measurement of the difference between two admittances, the inputs are applied to Y+ and Y- respectively. The input applied to Y- is used to subtract G and B from Y+ to provide a corrected indication on the Model 100B or 100C. Note that G is always positive, whereas B can be positive or negative.

1-CASE GROUND
2-PWR. LINE GROUND
3- CIRCUIT GROUND



MODEL 100 PA 1008

GROUND LUG LOCATION

FIGURE 1-2

SECTION II

PRINCIPLES OF OPERATION

2-1 GENERAL DESCRIPTION

a. Figure 2-1 is a block diagram and figure 2-2 is a schematic diagram (Drawing No. 100,195) of the Differential Admittance Adapter Model 100-PA-1008.

b. A 3-volt reference signal is applied to a Differential Current Transformer which produces a voltage proportional to and in phase with the current, and is proportional to the amplitude of the unknown admittance.

c. In the Differential Mode, the voltage is proportional to the difference in current and is proportional to the vector difference in phase, and subsequently is proportional to the amplitude of the differences of admittances.

d. The voltage representing the current (equal to 30 mv full scale for each admittance range) is scaled to produce a voltage which is applied to the Z-Y amplifier of the Series 100.

e. The 3-volt reference signal is also applied to the Series 100 to produce in-phase and 90° phase square waves as described in the Model 100B or Model 100C Instruction Manuals.

f. The sine-wave signal voltage representing current, the in-phase square wave and the 90° in-phase square wave are the necessary inputs for the 100 Series units to produce a measurement of $Y = G \pm jB$.

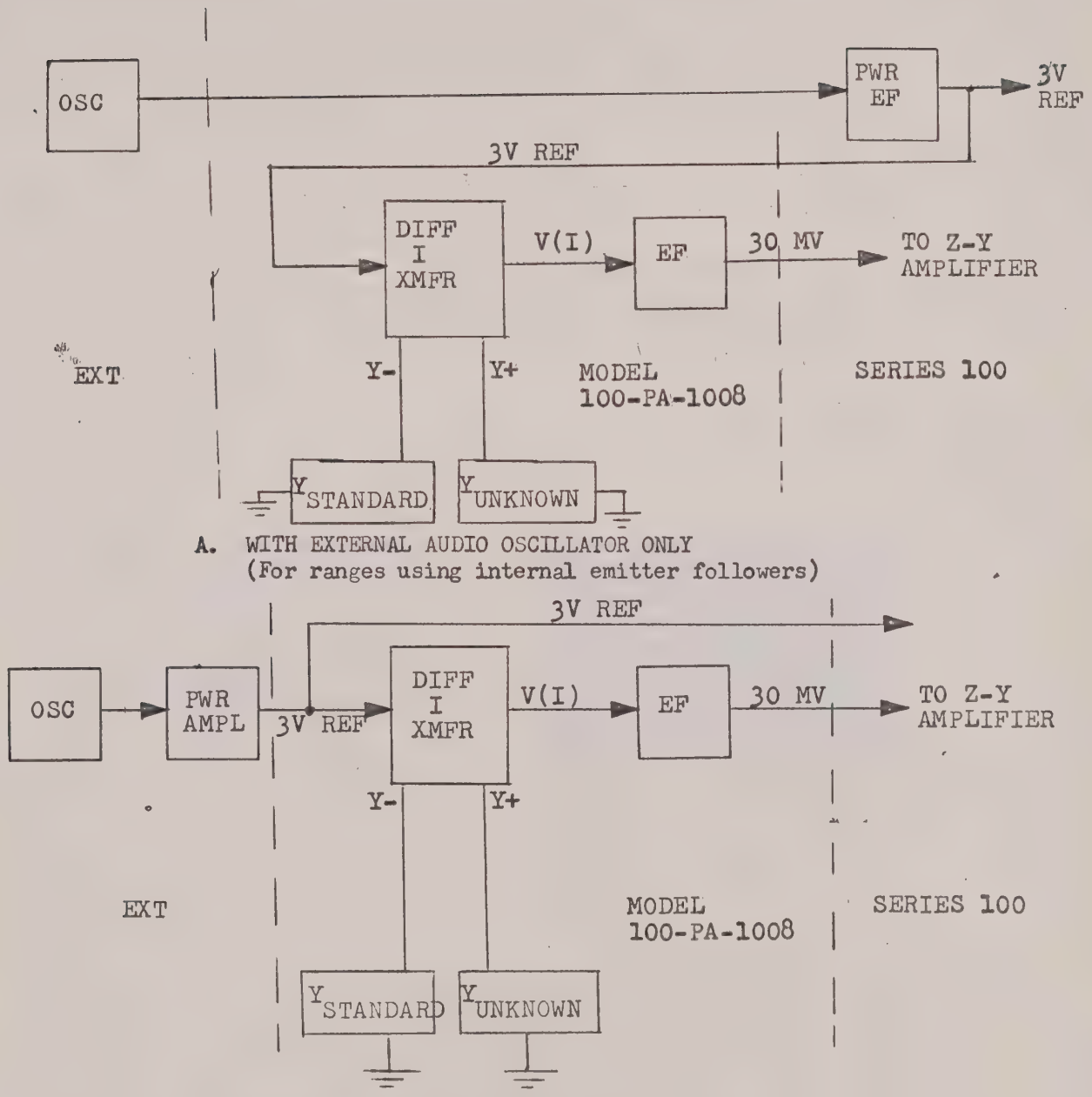


Figure 2-1. Block Diagram of the Differential Admittance Adapter

Revised Feb. 1968

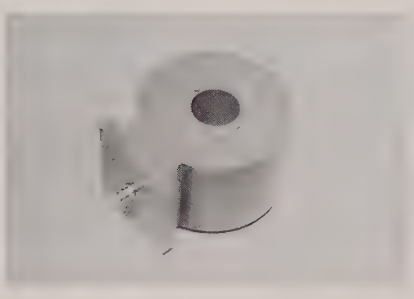
CURRENT TRANSFORMERS
Models TR 2004 and TR 2005

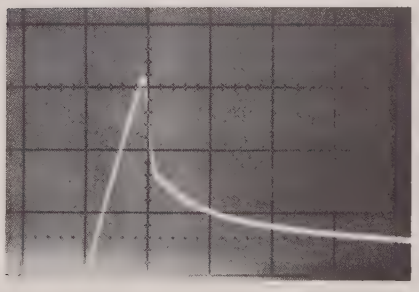
Featuring

- Wide frequency response
- Excellent pulse response
- Negligible phase shift
- Broad dynamic range
- High voltage isolation

Applications

- Testing sonar projectors
- Complex immitance measurements
- Measuring recovery currents in SCR's
- Measuring electron beam currents
- Controlling a.c. feedback systems





Recovery current transient in silicon controlled rectifier

These instruments produce an a.c. or pulse voltage which is a true linear reproduction of input current over a broad dynamic range for use in acoustical, video and electronic measurements and control. Constructed with magnetic cores of exceptionally high permeability, large cross section and low loss, these transformers display outstanding amplitude and phase fidelity from very low to high frequencies, as well as faithful response to current pulses and other transients. The incorporation of a Faraday shield around the secondary provides excellent electrostatic isolation between primary and secondary, making these instruments particularly useful for measuring currents in circuits while under high a.c. voltage.

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SPECIFICATIONS

Electrical

Characteristic	TR 2004	TR 2005
Sensitivity (volts rms/amp rms)[1]	0.1 $\pm^{0}_{1}$ %	1.0 $\pm^{0}_{1}$ %
Square Pulse Input		
Max. current (pk. amps)	10,000	1,000
Rise time	use with input rise times greater than 1 microsec.	40 nanosec. approx.
Droop (%/microsecond)	1×10^{-4} %	1×10^{-2} %
Max Amp-sec per pulse[2]	1	0.1
For Sinusoidal Input		
Amplitude Limit [3]		
Mid and High freq	100 amps rms above 17 cps	10 amps rms above 100 cps
Low freq (amps pk/cps)	9.0 (e.g., 90A pk at 10 cps)	0.15 (e.g. 7.5A pk at 50 cps)
Useful Fequency Range	0.25 cps to 700 kcps	20 cps to 10 mc
Amplitude Response with Freq. +0% —1% Limits	4 cps to 100 kcps	1 kcps to 4 mc
Low frequencies	3 db at 0.25 cps	3 db at 20 cps —3% at 200 cps, —5% at 100 cps, 3 db at 10 mc
High frequencies	3 db up to 700 kcps + 2.5% at 300 kcps + 7 % at 400 kcps	
Phase response ± 0.8° Limit	20 cps to 100 kcps	1 kcps to 2 mc
Low frequencies	1.5° at 10 cps, 2.9° at 5 cps	2° at 500 cps, 4° at 250 cps, 8° at 100 cps, 13° at 50 cps
High frequencies	1.5° at 200 kcps, 2.2° at 300 kcps	2.7° at 5 mc
Electrostatic Shielding With 1000 volts rms at 5 kc on primary, secondary output corresponds to less than:	10^{-4} ampere turns through primary	10^{-5} ampere turns through primary
Maximum Insertion Impedance	0.0002 ohms	0.02 ohms
Maximum Voltage:	15,000 volts pk from surface to high voltage 30,000 volts pk possible with primary insulation	
Typical Capacitance added to circuit:	6 pf in oil 3 pf in air	
Recommended Load:	greater than 10,000 ohms in parallel with less than 20 pfd	

Mechanical

Connector: BNC

Weight: 4 pounds approx.

Shipping Weight: 8 pounds approx.

Dimensions: 5″ OD x 1¼″ ID x 2½″ high plus (approx.) mounting flange (4 mounting holes on flange: 3/16″ D on centers 1-9/16″ x 2-1/2″)

[1] With single turn primary. For multiple turn primary the sensitivity increases in proportion to the number of primary turns.
[2] Small bias current may be required through secondary to attain maximum. In no other case should d.c. bias be used.
[3] Continuous operation above rating may damage unit.

Data subject to change without notice

HIGH VOLTAGE ATTENUATION TRANSFORMER

Model TR 2003

Bulletin TR 2003

• Product Information

Featuring:

- Input levels up to 10,000 volts rms, grounded or ungrounded
- Excellent amplitude and phase fidelity over wide frequency range — 20 cps to 30 kcps
- Low power absorption
- High input impedance — low output impedance

Applications:

- Measurement of amplitude and phase of A.C. plate voltage of push-pull amplifier
- Impedance, phase and power measurements on high power electroacoustical transducers
- Testing of high voltage components such as inductors and transformers
- Excellent for measuring both single-ended and push-pull sources

This instrument has been specifically designed for measuring phase and amplitude of high A.C. voltages associated with power amplifiers, transformers, transmission systems and electroacoustical transducers. Having a turns ratio of 1,000:1, this transformer readily converts many standard laboratory indicating instruments for high voltage measurements without the need for other accessories. For example, this device can be used with complex impedance meters, phasemeters, vacuum tube voltmeters or oscilloscopes for analyzing waveform, phase angle, amplitude, power or other characteristics of high voltage equipment.

Having excellent isolation between primary and secondary, this is ideal for measuring off-ground sources, such as on the plates of push-pull amplifiers, or other equipment such as transducers being driven under balanced conditions. In addition the transformer has been designed for high input impedance, minimum power absorption, and low output impedance.

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Our New Address
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PLAINFIELD, N. J. 07062

SPECIFICATIONS

Electrical

TURNS RATIO

1,000 to 1, within ±1% at 1 kcps

INPUT FOR MEASURING

Single-ended voltages

Push-pull voltages

FREQUENCY RESPONSE

Amplitude: Push-pull — flat within ±1% from 20 cps to 30 kcps

Single-ended — flat within ±1% from 20 cps to 9KC

Phase: Push-pull — within ±2° from 20 cps to 30 kcps

Single-ended — within ±2° from 20 cps to 9KC

PRIMARY CENTER TAP

Within 0.5% of true center

INTERNAL POWER ABSORPTION

Increases as square of voltage, to less than 10 watts at full voltage limit

LOAD IMPEDANCE

Characteristics stated herein apply for resistive loads between 1K ohm and 10K ohm

INPUT VOLTAGE LIMIT

Push-pull, CT grounded: Up to 10KV rms from 100 cps to 30 kcps

Single-ended: Up to 10KV rms from 100 cps to 9 kcps

With voltage bias: 0-peak voltage from either terminal to case shall not exceed 15KV

Below 100 cps: Progressively reduced voltage

INPUT IMPEDANCE (VECTOR)

Above 100 cps: Approximately 2 megohms over specified frequency range

Below 100 cps: Progressively decreasing with lower frequency (approximately 1 megohm at 60 cps)

INSULATION TO CASE

Primary: 1,000 megohms minimum at 1KV

Secondary: 1,000 megohms minimum at 1KV

BREAKDOWN TO CASE

Primary: 18KV rms minimum at 60 cps

Secondary: 1KV rms minimum at 60 cps

BIAS CURRENT

DC bias current should NOT be placed through windings

Mechanical

SIZE

Approximately 6¾" x 5¼" x 7" high excluding terminals and mounting studs

TERMINALS

Primary: 3 steatite feed through

Secondary: 2 steatite feed through

CONSTRUCTION

Steel encased, oil filled, mounting studs 5⁵⁄₁₆" x 3¼" centers

WEIGHT

Approximately 26 pounds

SHIPPING WEIGHT

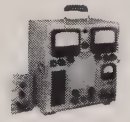
Approximately 32 pounds

Data subject to change without notice

PRECISION INSTRUMENTS TO MEASURE

■ IMPEDANCE ■ ADMITTANCE ■ TRANSFER FUNCTION
■ PHASE ANGLE ■ CURRENT ■ QUALITY FACTOR Q
■ REAL AND IMAGINARY POWER

100 SERIES WIDEBAND COMPLEX IMPEDANCE-ADMITTANCE METERS



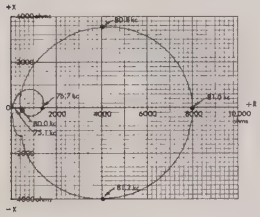
MODEL 100B

Measures R, X, G, B, and real and imaginary components of output to input voltage ratio

- **MEASURES**
  - Impedance
  - Admittance
  - Transfer function
  - Power
- **FOR**
  - Transducer calibration
  - Production testing of resistors, capacitors and inductors
  - Filter and other network design and analysis
  - Physiological studies
- **FEATURING**
  - Rapid measurements
  - Direct reading—no bridge balance
  - Wide frequency range—100 hz to 200 khz (Broader on special request)
  - DC Outputs for frequency or complex plane plotting

MODEL 100C

Measures R, X, G, B, $|Z|$, $|Y|$, $\angle\theta_z$ and $\angle\theta_y$ as well as amplitude, phase and real and imaginary components of voltage transfer ratio



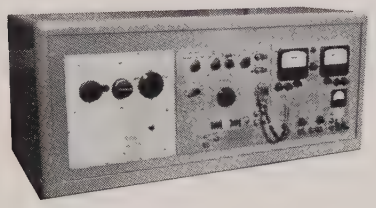
Complex impedance plane locus of piezoelectric ceramic (Plotted on X-Y recorder in 20 seconds)

Standard or special plug-ins and adapters are available for measuring under a wide variety of conditions, including at high and low power, balanced or unbalanced connections, differential admittance, hybrid bridge or comparator circuits, etc. Typical units are described at the right.

TYPICAL ADAPTER CHARACTERISTICS

Model	Measures	Ranges
100-PA-1001	Z or Y	1Ω to 50KΩ; 1μ℧ to 50Kμ℧; 100 to 200,000hz
100-PA-1002	Y w/one lead at ground	1μ℧ to 5Kμ℧; 100 to 200,000hz
100-PA-1004	Low Z	0.1Ω to 5KΩ; 100 to 200,000hz
100-PA-1005	Z or Y	1Ω to 50KΩ; 1μ℧ to 50Kμ℧; 100 to 200,000hz
100-PA-1006	Y at high input power	10μ℧ to 100Kμ℧; 3 to 3000v; 100 to 50,000hz
100-PA-1008	Differential Y	50μ℧ to 500Kμ℧; 100 to 100,000hz
100-PA-1010	Z at high input power	1Ω to 10KΩ; 3 to 3000v; 100 to 50,000hz
100-PA-1011A	Capacitance and loss	up to 0.1 mfd; 6 to 6000v; loss to 100%
100-PA-1012A	Piezo activity tester	Y; fr; fa; 100Khz to 250Khz

PULSE IMPEDANCE SYSTEMS ALSO AVAILABLE



DIELECTRIC TEST FACILITY

System S-4

- For rapid laboratory and production testing of ferroelectric and other components — measures capacitance and dissipation at low and high voltage levels as well as f_R and f_A.
- System is complete
- Frequency: 1 KC (or as otherwise specified)
- Applied voltage: 6V to 6 KV rms, up to 1 KVA zero p.f. leading
- Capacitance range: up to 0.1 mfd.
- Loss tangent: up to 100%
- Systems can be tailored to specific requirements

HIGH VOLTAGE VARIABLE CAPACITOR

Model N113

A precision low loss high voltage capacitor for use in bridges and other capacitance measuring systems, as well as in tuning systems.

Voltage: up to 10 KV pk

Capacitance: adjustable from 150 to 8000 pfd

(Trimmer included for cable balancing)

Broadband Current Transformers

- For CW and pulse measurements
- Excellent Amplitude, phase and rise time response

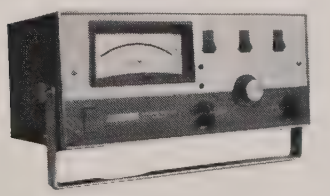
Characteristic	Model TR2004	Model TR2005
Freq. Range	0.25hz to 700Khz	20hz to 10 mhz
Rise Time	10^{-6} sec.	40×10^{-9} sec.
Max. CW Amps (rms)	100	10
Max. Pulse Amps	10,000	1,000
Sensitivity (V/A)	0.1	1.0

Also available:
High power isolation transformers
High voltage step down transformers

WIDE BAND PHASEMETER

301 Series

An excellent general purpose instrument for any electrical or electronics laboratory or inspection department.



- Completely transistorized
- 5 hz to 500 khz
- Input levels: 50 mv to 150 v rms, independent amplitudes, no attenuator controls
- 1° accuracy nominal
- Square wave output
- DC output available —0 to +3.600 volts corresponding to 0 to 360° —at low impedance

Available in portable or rack mount.

VECTOR IMPEDANCE AMPLITUDE METER

320 Series

An inexpensive instrument for rapid testing of impedance or transfer function.

- Completely transistorized
- Has AC outputs for use by 301 phasemeter to measure phase angle of impedance or transfer function
- 5 hz to 500 khz
- Range: 1 ohm to 10 megohms
- Capacitance: 0.1 pfd to 10,000 mfd
- Inductance: 1 microhenry to 100,000 henries
- Self contained oscillator

Available in portable or rack mount.

FOR COMPLETE TECHNICAL, PRICE OR DELIVERY INFORMATION, WRITE, WIRE OR CALL TODAY.

DRANETZ ENGINEERING LABORATORIES INC.

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Bulletin 206
July 1967

DRANETZ

TONE BURST/TIMING GENERATOR

MODEL 206

FEATURES

- Contains all necessary timing and transmitting gate circuits
- Coincident gate-turns on and off at zero crossings
- Simplified operation-controls calibrated in time and in functional units
- Compatible with existing pulse calibrating systems
- All solid state, modular construction, small size, self-contained power supply
- Wide frequency range-50Hz to 3mHz

APPLICATIONS

- Complex impedance, admittance and power measurements on electro-acoustical transducers
- Transmitting and receiving response and beam pattern testing of underwater transducers
- Measurement of acoustical fields and propagation under pulse conditions
- Phased array analysis
- Transfer function measurements
- Useful for simultaneous multi-transducer calibrations

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DESCRIPTION

The Dranetz Tone Burst/Timing Generator Model 206 provides the basic facility for converting a CW generating and test system into a gated CW or single shot tone burst system. This single instrument performs the following functions:

(1) Controls the signal on time and its repetition rate
(2) Gates the signal on and off coincident with zero axis crossing to minimize noise and transients
(3) Provides coincident and delayed pulses for synchronizing and blanking measuring and monitoring equipment
(4) Provides a square wave output of variable delay and width for receiver gating

The operator may select CW or gated Modes of operation, the latter being controlled by automatic internal trigger, external trigger, or front panel push button (single shot). The initial trigger sets up an automatic sequence of controlled pulses for transmitter gating, receiver gating, and monitor and recorder control. The transmitter gate turns on the sinusoidal signal at the first positive going crossing following the initial trigger, and turns off the signal at the first positive going crossing following the time selected by the Transmit Pulse Width Control. For convenience the pulse width control is also calibrated in percent duty cycle. Coincident with the initial trigger, the instrument produces an output pulse for synchronizing other devices such as the Dranetz Model 202 Vector Component Computer, the Dranetz Model 215 Sampling Voltmeter, oscilloscopes, or commercially available E-I Normalizers. This pulse can also be used to slave other Dranetz Model 206 Tone Burst/Timing Generators in order to provide simultaneous calibration of several hydrophones or projectors placed in a single body of water. In addition to this coincident output pulse, a pulse having controlled delay is produced for automatic transient masking of certain monitoring instruments such as the Dranetz Model 215 Sampling Voltmeter. For convenience, the delay control is calibrated in percent of repetition period as well as time. After a preset delay, the instrument also produces a square wave for controlling an external receiver gate. In addition to time calibration, the delay control is also calibrated in feet of acoustical travel. Likewise the width control is also calibrated in percent of the repetition period.

This instrument has been designed for maximum versatility coupled with ease and reliability of operation. It features separation of grounds (i.e., circuit, power and chassis) and transformer interface coupling wherever possible to avoid system ground loops. It provides pulsing shutdown due to system overload or malfunction; and front panel lamps provide an indication of gating and/or disabling condition. This instrument can be provided in portable housing or provided in Dranetz type MR11 case ($3\frac{1}{2}$" high), for both portable and rack use. In the MR11 case, only 2/3 of the front panel is utilized by the Model 206, allowing space for other devices such as one of the Dranetz 380E series oscillators.

ELECTRICAL

MODES OF OPERATION:

CW

Single tone burst-external pulse or front panel push button for manual pulsing

Externally controlled repetition rate (provides for multiple simultaneous transmissions)

Internally controlled repetition rate

SIGNAL CHANNEL:

Frequency range: 50 Hz to 3mHz

Input:

Level Sinusoidal signal, 1 volt RMS ±20%

Impedance: >2KΩ shunted by 100pf max

Output:

(1) Level: Adjustable from 0.1 to 1 volt RMS into 75Ω load over full frequency range; adjustable from 0.5 to 5 volts RMS into >10kΩ load (source impedance 600Ω) at frequencies up to 0.5mHz

(2) Distortion: Less than ¼% from 50Hz to 0.5mHz; less than 1% to 0.5mHz

(3) Output noise (pedestal, switching transients, etc.): 60 db below full output

Type of Modulation: Zero crossing turn on and zero crossing turn off; less than 10 nanoseconds coincidence error.

ADJUSTABLE TIMING CONTROLS:

Repetition rate (internal): Front panel control, 100 microseconds to 10 seconds

Transmitting pulse width: Front panel control, calibrated in time (10 microseconds to 1 second) and in percent of duty cycle (1 to 100%)

Transmit monitor delay (for use with certain monitoring devices using external blanking during transient period): Front panel control, delays pulse behind transmitting turn on pulse, calibrated in time (5 microseconds to 1 second) and in percent of repetition period (1 to 100%)

Receiver delay: Front panel control, provides delay corresponding to signal transmission time, calibrated in time (100 microseconds to 10 seconds) and in underwater distance between transmitting and receiving transducers (1 to 100 feet)

Receiver gate width: Front panel control, calibrated in time (10 microseconds to 1 second) and in percent transmit gate time (10 to 100%)

INPUT CONTROL PULSES (EXTERNAL CONTROL ONLY):

External repetition rate: Plus or minus 5 volt pulse, step or square wave into 3kΩ load, transformer input, rise time (10-90%) 50 microseconds max.

Disabling input (disables pulse timing generator in event of system overload or other system malfunction): Plus or minus 5 volt pulse, step or square wave into 3kΩ load, transformer input, rise time (10-90%) 50 microseconds max. Causes turn off in 50 microseconds max.

OUTPUT CONTROL VOLTAGES:

Sync Trigger Output (for scope sync, monitor instruments, etc.): +5 volt pulse, 50 microseconds pulse width coincident with transmitting signal turn on, transformer output, output impedance 3k ohms.

Transmitter monitor delay trigger: +5 volt pulse, 50 microseconds pulse width, transformer output, 3k ohms, controlled by Transmit Monitor Delay Control.

Receiver delay and pulse width: +5 volt square wave, having positive going transient corresponding to Receiver Delay Control, and pulse width corresponding to Receiver Gate Width Control; rise and fall time less than 50 microseconds, output impedance less than 3k ohms.

Gate Output (For certain controlling instruments such as Commercial E-I Normalizers): +5 volt square wave, having positive going transient coincident with transmitting signal turn on and negative going transient coincident with transmitting signal turn off; rise and fall times less than 50 microseconds, output impedance less than 3k ohms.

INPUT POWER:

105-125V, 50-60 Hz, 40 watts

GROUNDING: Separate chassis, circuit and power line grounds to minimize problems of ground loops.

MECHANICAL:

SIZE: Portable: 4" high x 12" wide x 11" deep.

For rack mounting, mounts in Dranetz case MR11, 3½" high x 19" wide x 11" deep (requires 2/3 panel width).

WEIGHT: 16 pounds

SHIPPING WEIGHT: 25 pounds

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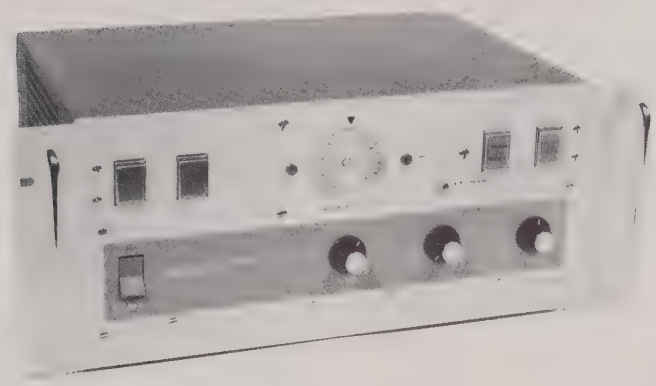
SERVO CONTROL UNIT
Model 501

Bulletin 501

Revised Sept. 1, 1967



Features:

- **Precision control of signal level**
- **Broad frequency range**
- **Wide dynamic range**
- **Ground isolation of signals**
- **Useful for CW, gated CW and DC control**

Applications:

- **Measurement of complex impedance and admittance under high power**
- **Constant level control for acoustical calibrations**
- **Vibration amplitude control for mechanical impedance measurements**
- **Parameter control in programmed industrial process systems**

The Dranetz Model 501 Servo Control Unit is designed to maintain the level of an electrical signal at a precisely controlled value, regardless of fluctuations in source level or in load. For example, by the use of this instrument as a feedback control, the amplitude of current in a transducer may be held constant as the frequency is swept through the resonant frequency of the transducer.

By proper scaling of signals this unit can be applied to the control of voltage, power, acceleration, velocity, displacement, pressure or other physical functions. In addition to controlling sinusoidal CW signals, this unit is also capable of controlling d.c. and gated CW signals.

The Model 501 is a precision electromechanical servo system which measures the voltage at a sampling point, compares it with an internal reference voltage, and controls the position of a precision potentiometer, to adjust this to a predetermined level. The use of a special precision film potentiometer assures excellent resolution over the full dynamic range; and the use of a 400 cps servo loop improves stability and response time, and minimizes 60 cps pickup.

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SPECIFICATIONS

Electrical

SIGNAL FREQUENCY RANGE

100 cps to 100 kcps, CW (or gated CW when used with external peak detector), DC.

SIGNAL INPUT

Voltage level: 0.5 to 20 volts rms.

Input impedance:

Minimum: 20KΩ shunted by input impedance of following equipment (e.g., power amplifier).

Maximum: 20KΩ.

Leads: 2 wire, single-ended, both isolated from ground.

SIGNAL OUTPUT

Level: Varies from 0 to 40 db below input level, depending on servo position.

Input impedance of following equipment (e.g., power amplifier): Should be 100KΩ or higher.

Input leads to amplifier: 2 wire, single-ended, low side connected to low side of signal input.

FEEDBACK CONTROL VOLTAGE

CW: Between 0.5 and 5 volts rms into 50,000 ohms.

DC or gated CW: Approximately 2 volts d.c. required at level of balance.

CONTROL CHARACTERISTICS

Dynamic range: 40 db.

Level control: Maintains feedback control voltage within ±2% for change in input signal or power amplifier load of ±20 db.

Response time: Approximately 0.5 seconds for full 20 db correction for DC and CW.

OVERSIGNAL PROTECTION

Equipped with automatic signal cutoff for over-level signals.

POWER REQUIRED

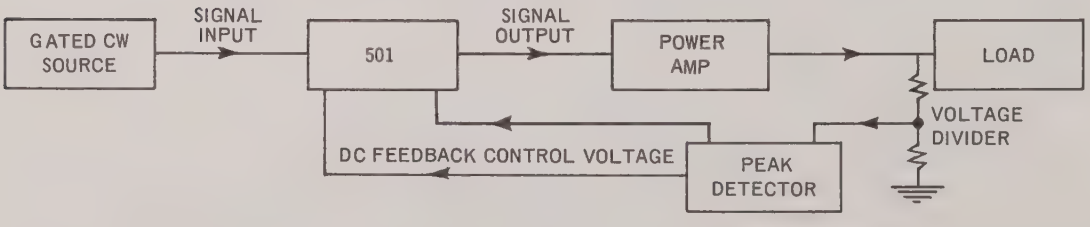
105-125 volts, 60-400 cps, 0.6 amps rms.

Mechanical

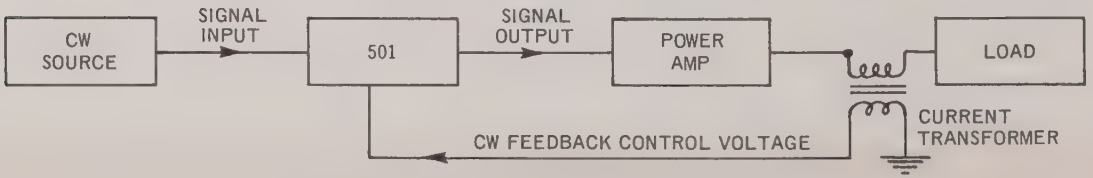
Size: 7" high x 19" wide x 11½" deep (for mounting in 19" rack). *Weight: Approximately 20 pounds.*

Shipping weight: Approximately 40 pounds.

EXAMPLES OF APPLICATION OF SERVO CONTROL UNIT
FOR MAINTAINING CONSTANT VOLTAGE OR CURRENT



CONSTANT VOLTAGE LEVEL CONTROL FOR GATED CW SIGNAL



CONSTANT CURRENT CONTROL FOR CW SIGNAL

Data subject to change without notice

Completely Transistorized
VECTOR IMPEDANCE METER
Series 320

Bulletin 320

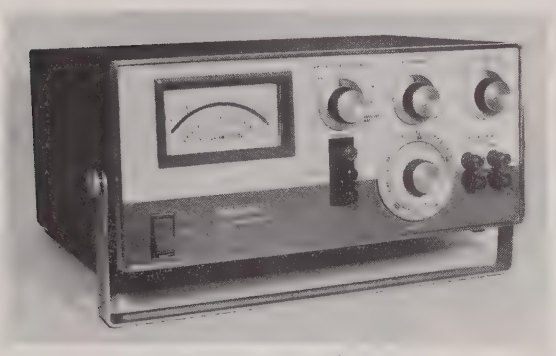
Revised Sept. 1, 1967

Features:

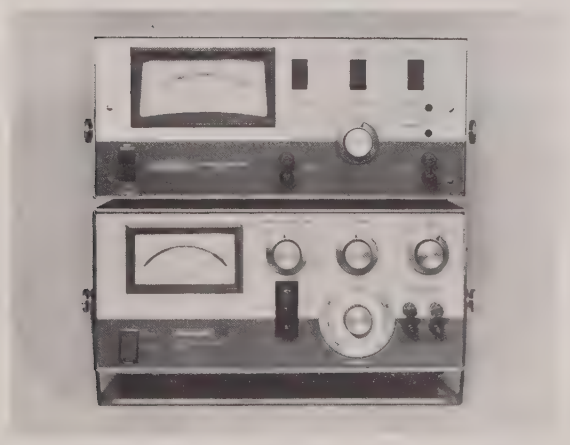
- Direct reading of amplitude of impedance or transfer function
- Wide frequency range — 5 hz to 500 khz
- Wide $|Z|$ range — 1 to 10^7 ohms
- With 301 Series Phasemeter, provides impedance angle readings as well

Applications:

- Incoming inspection of resistors, capacitors, and inductors
- Design and test of filter and other networks
- Measurement of input and output impedance of amplifiers
- Production testing of components
- General purpose signal generator



Model 320A Vector Impedance Meter



Model 320A with Dranetz Model 301 wideband Phasemeter

Dranetz Series 320 Vector Amplitude Impedance Meters are designed as an inexpensive answer to the every day problems of rapid and direct measurement of impedance or transfer function with moderate accuracy. In addition, at premarked frequencies, capacitance and inductance may be read directly from the panel meter. A db scale is provided to facilitate Q measurement. These instruments have two a.c. outputs which, when connected to the input of the Dranetz 301 phasemeter, provide a direct reading of impedance angle. D.C. outputs and rack mountings are among available options.

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SPECIFICATIONS

Electrical

FREQUENCY RANGE
5 hz to 500 khz.

IMPEDANCE RANGE
1 ohm to 10 megohms, in 7 ranges.

INDUCTANCE RANGE
1 μh to 100,000 h, in 11 ranges.

CAPACITANCE RANGE
0.1 pfd to 10,000 mfd in 11 ranges.

SELF CONTAINED OSCILLATOR
5 hz to 500 khz, 5 ranges, approximately 3 V rms, ±3% freq. accuracy.

SIGNAL ACROSS UNKNOWN
Below 1000 ohms, less than 35 mv rms. Above 1000 ohms, approx. 3 volts rms.

CIRCUITRY
Completely transistorized.

AC OUTPUTS
For input to Model 301 phasemeter.

AMPLITUDE ACCURACY
(1) 20 hz to 100 khz: better than 5% of reading.
(2) Frequency extremes: better than 7% at 5 hz and 10% at 500 khz.

PHASE ACCURACY
(A.C. Outputs)
(1) 20 hz to 100 khz: better than 2½°.
(2) Low frequency: better than 4° at 5 hz.
(3) High frequency: from 10 to 10^6 ohms, better than 5° at 500 khz; for other values of $|Z|$ better than 10° at 500 khz.

AC POWER INPUT
105-125 volts, 60-400 hz, 0.1 amps rms approx.

OPTIONAL FEATURES
(Specify Models 320A, 320AR)

(1) D.C. output 0 to +1 volt proportional to $|Z|$ below 1000 ohms, proportional to $1/|Z|$ above 1000 ohms.
(2) D.C. output 0 to +1 volt proportional to freq. dial position.
(3) A.C. output for use by counter for accurate freq. measurement.
(4) External oscillator input for use with special signal sources.

Mechanical

Size: Portable (320, 320A) 7" high X 16½" wide X 11½" deep, supplied with carrying handle. Rack mount (320R, 320AR): similar to portable, except angle brackets supplied for 19" rack mounting, instead of carrying handle.

Weight: Approximately 18 pounds.

Shipping weight: Approximately 27 pounds.

Data subject to change without notice

BULLETIN 202
JAN. 1967

DRANETZ
VECTOR COMPONENT COMPUTER
Model 202

**for PULSED or CW measurements of
COMPLEX IMPEDANCE, ADMITTANCE,
TRANSFER FUNCTION OR POWER**

FEATURES:

- Measurements for CW, gated CW or single tone burst signals
- Wide frequency range – 50 Hz to 300 kHz
- Selected sampling times – 0.5 to 500 milliseconds
- DC Outputs for direct readout or automatic recording – holding time up to 3 minutes for single burst
- Compatible with all Dranetz 100-PA-series plug-ins and adapters
- Completely Transistorized
- AUTO-CORRECT™ circuits which eliminate errors due to variation in signal source level
- Internal delay to eliminate effects of transients

APPLICATIONS:

- Measurement of complex impedance and admittance of electroacoustical transducers under low and high power
- Measurement of real and imaginary input power.
- Plotting of transmitting and receiving response of projectors or hydrophones
- Use as a phase-lock detector for low level tone burst signals

PATENT PENDING

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The Model 202 Vector Component Computer provides a direct computation of the in-phase and quadrature components of a sine wave signal voltage, using as a reference the phase of a second input voltage of the same frequency. Two DC output voltages are produced, one proportional to to the in-phase component, the other proportional to the quadrature component of the signal. This instrument performs these computations for both CW and gated (repetitive or single shot) CW signals, and because of its direct reading capability, can be used for direct plotting on X-Y or strip chart recorders, digital voltmeters, or other readout devices. In a second mode of operation this instrument produces a DC output voltage proportional to the vector magnitude of the sine wave signal.

The Model 202 Vector Component Computer is particularly useful for measuring and plotting the two components of complex impedance or complex admittance over a broad frequency range. By means of a front end plug-in (either 100-PA- or 202-PA-series plug-ins or adapters can be used), the inputs are scaled to represent current through and voltage across the unknown immittance; thus the DC outputs are presented directly in units of the equivalent series resistance and reactance, or of the equivalent parallel conductance and susceptance. In an alternate mode of operation, one of the outputs can be made to be proportional to vector immittance amplitude. Depending on the plug-in or adapter used, measurements can be made under a wide range of conditions, including low or high power, direct or differential immittance, and under various conditions of grounding. A typical system used for complex impedance-admittance measurements of a projector under power is shown in Figure 1. The Servo Sampler and Servo Control Unit shown are normally needed only for automatic frequency plots of impedance under moderate or high power where constant current must be maintained by the power signal source. Under most other conditions, such as low power impedance, or low or high power admittance the AUTO-CORRECT™ system in the Model 202 Computer eliminates errors due to power amplifier output level change (up to ± 20%).

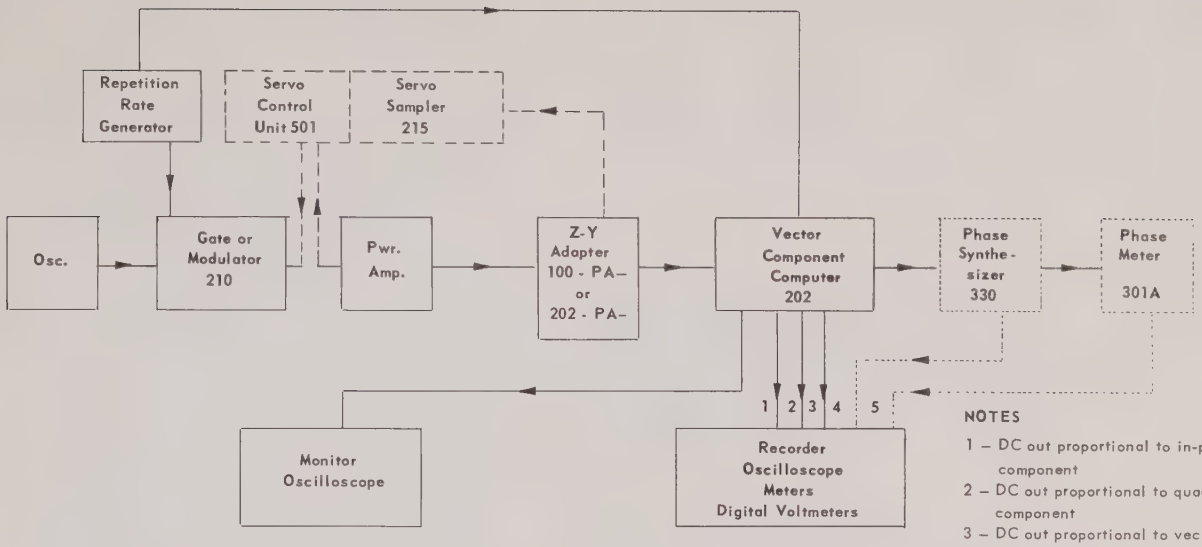
The system is also capable of providing simultaneous DC outputs directly proportional to vector magnitude and phase angle, by the addition of the Phase Synthesizer Model 330 and Phasemeter Model 301A.

This unit can also be used for measurement of transfer function or other four terminal measurements. Such measurements are particularly useful in the analysis of the surface motion of a transducer and in the study of spatial and time relationships in sound pressure fields. Because of the unique noise rejection features of this instrument, it is particularly effective with the Model 330 Phase Synthesizer as a gated receiver for hydrophones having low output signals.

PRINCIPLE OF OPERATION

The basic operation of this instrument utilizes a sampling action, regardless of whether the input signal is CW or gated CW. The measuring cycle, which is started by a trigger pulse, consists of an adjustable time delay to allow signal transients to disappear, a selectable sampling-computing period, and a hold period. In the CW mode of operation, an internal generator provides repetitive cycling, while in the gated CW mode of operation, this is provided by an external Repetition Rate Generator which also controls the modulator.

A technical breakthrough in the art of sampling and computing has led to an unusual combination of outstanding features. (1) A synchronous integrating full wave type detector reduces the effects of undesired signals such as noise and out-of-band frequencies, which are usually present in axis crossing or other systems; (2) the sampling period is a constant time over an entire range of frequencies, resulting in maximum noise reduction; normally a minimum sampling period of 8 cycles is required, however, under certain conditions the sampling time may be reduced to 4 full cycles of the signal; (3) effects of moderate levels of harmonics (up to 10% THD) due to the immittance are reduced; even harmonics have no effect on the DC output, while the output error due to odd harmonics is reduced by a factor of at least 3, 5, 7, 9, etc. for the 3rd, 5th, 7th, 9th, etc. harmonic; and (4) an AUTO-CORRECT™ provision automatically corrects both DC outputs for signal source level variations of up to ± 20%. Thus it is not necessary to maintain constant voltage at the output of the signal generator or power amplifier. Furthermore, in those cases where a Servo Control Unit is used to maintain constant current, the AUTO-CORRECT™ circuits provide a second order correction for the servo error.



NOTES

(1) Blocks in dashed lines are normally required only for high power impedance measurements.

(2) Blocks in dotted lines for simultaneous vector magnitude and phase outputs.

NOTES

1 – DC out proportional to in-phase component

2 – DC out proportional to quadrature component

3 – DC out proportional to vector magnitude (not simultaneous with DC 1 and DC 2)

4 – DC out proportional to vector amplitude (simultaneous with DC 1 and DC 2)

5 – DC out proportional to phase angle (simultaneous with DC1 and DC 2)

FIGURE 1

SYSTEM FOR MEASURING COMPLEX IMPEDANCE OR ADMITTANCE AT HIGH DRIVING POWER UNDER GATED OR CW CONDITIONS.

SPECIFICATIONS – ELECTRICAL

1. PURPOSE:

   For computation of the in-phase and quadrature components or vector magnitude of an AC voltage which may be a CW, gated CW or single tone burst signal. Applicable to measurement of complex impedance, real and imaginary power, and transfer function.

2. FREQUENCY RANGE: 50 Hz to 300 kHz

3. MEASUREMENT MODES (selectable):

   A. DC output proportional to in-phase and quadrature components of vector.

   B. DC output proportional to vector magnitude.

4. REPETITION RATES:

   A. On CW, automatic recycling at fixed repetition rates of 1.5, 15 and 100 samples/sec.

   B. On gated CW, externally triggered, from 100 samples/sec to 1 sample per 200 seconds.

   C. Single pulse operation.

5. SAMPLING TIMES: selectable from 0.5 to 500 ms.

6. HOLD TIMES: up to 3 minutes

7. ACCURACY (of reconstructed voltage vector)

   A. Amplitude: Max error does not exceed ± 1% FS ± 1% of reading.

   B. Phase: Error less than ± 2°

8. INPUTS:

   A. Sinusoidal (CW, gated CW or tone burst)

      (1) For transfer function measurements:

         (A) Reference Voltage: 8.5V pk-pk ± 20% into 5KΩ

         (B) Signal voltage: 0 to 120 mv pk-pk in component display mode: 12 to 120 mv pk-pk in vector magnitude display mode (note: when using the Phase Synthesizer Model 330, the DC output is proportional to vector magnitude over the entire range of 0 to 120 mv pk-pk).

      (2) For impedance or admittance measurements, using Dranetz 100-PA-series low power plug-ins:

         3 volts rms (8.5V pk-pk) ± 20% for CW, gated CW or tone burst. Input Z greater than 5KΩ shunted by 100 pf. For high admittances, low source impedance may be required (similar to requirement for 100-PA-plug-in used with 100C main frame – See Dranetz Bulletin 100).

      (3) For impedance or admittance measurements, using Dranetz 100-PA-series high power adapters: source must be capable of applying required voltage and current level into test device.

(OVER)

B. Control (not required for CW)

Repetition Rate: 5 volt pulse or gate, rise time (10-90%) 50 μ sec max; related to turn on of signal source in gated CW operation. Input of Vector Computer is ungrounded (transformer input); impedance 3KΩ minimum shunted by 100 pf max.

9. OUTPUTS:

A. DC outputs: two outputs of 0 to ±5 volts, approx. 200Ω output impedance, minimum load impedance 10KΩ. Proportional to in-phase and quadrature components of input signal in Vector Component mode. Proportional to vector magnitude in Vector Magnitude mode.

B. Oscilloscope monitor: two low impedance AC outputs corresponding to reference and signal inputs, scaled to approximately 2 V pk-pk for full scale; adjustable pedestal voltage to indicate position of sampling period.

C. Mark Output: +25 V pulse for Z axis intensification to be used with oscilloscope monitor outputs.

D. Scope synch: 5 volt pulse, coincident with repetition rate trigger.

E. Record – seek: -20V pulse 10μ sec. minimum width corresponding to completion of computing operations. For mute/unmute and pen lift of X-Y reorders (such as the H.P. 7590A) or trigger for digital voltmeters. Not present when disable signal occurs.

F. Disable: -25V DC when computer inputs or outputs are out of limits.

G. Reset output: -25V pulse for Z axis blanking of oscilloscopes. Pulse occurs immediately before sampling.

H. Out of limits: +5V DC when reference signal is above limit, -5V DC when reference signal is below limit, zero output under normal operation.

10. FRONT END PLUG-IN FEATURE

Instrument can accommodate general purpose and special plug-ins for a variety of applications. Plug-ins can be inserted from front panel (202-PA-series), rear panel (202-PAR-series) or both, with internal DC power of ± 24 volts available.

11. COMPATIBILITY WITH 100-PA-SERIES PLUG-INS AND ADAPTERS

This instrument is completely compatible (for both CW and gated CW) with all plug-ins and adapters (100-PA-series) designed for use with the Dranetz 100 series Complex Impedance-Admittance Meters (i.e., models 100B, 100B Mod. 4 and 100C). A rear panel plug-in (model 202-PAR-2501) and front panel bridging unit (Assembly #100,713) are included as a accessories for each instrument to accommodate 100-PA-series units.

12. OUTPUT COMPATIBILITY:

Compatible with:

(1) DC Meters
(2) Oscilloscopes – standard
(3) Oscilloscopes – signal translater
(4) Standard X-Y Recorders
(5) Auto-plot X-Y Recorders
(6) Digital Voltmeters
(7) A-D Recorders

13. INPUT POWER: 105 - 125V, 60 Hz, 120 watts max.

14. CONSTRUCTION: Entirely solid state, modular

MECHANICAL

1. Size: 8¾" high x 17" wide x 18" deep (will fit into 24" D hatch) Carrying handle each side.
2. Weight: 56 pounds max.; shipping 95 pounds max.
3. For rack mounting, hardware supplied for use with chassis slides.

ACCESSORIES FURNISHED

1. Rear panel plug-in 202-PAR-2501 (for 100-PA-series plug-ins)
2. Front panel bridging unit Assembly #100,173 (for 100-PA-series plug-ins)

ACCESSORY EQUIPMENT REQUIRED

1. Front and/or rear panel plug-in (such as 100-PA-series plug-ins or adapters)
2. Signal source (gated or ungated)
3. DC Output indicator or recorder (Portable or rack mount meters available for direct readout)
4. Repetition rate generator (for gated CW only)

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE

1-67-16M

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Bulletin TR-2001
Revised June 1967

3 KVA SHIELDED AUDIO ISOLATION TRANSFORMER

EXCELLENT FOR:

- Use with ac impedance and admittance bridges, particularly at high signal levels
- Providing isolation between power amplifiers and loads
- Providing isolation between ac power line and equipment grounds
- Driving reactive as well as resistive loads

The TR-2001 is used to couple low or high power between source and load, generator and bridge, or bridge and detector. Featuring an excellent combination of electrostatic shielding, low winding-to-shield capacitance and low leakage inductance, this device can handle a wide range of load impedances and is useful from below 60 cps to above 25 kcps.

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SPECIFICATIONS

Electrical

CONSTRUCTION: Consists of single shielded primary and three shielded secondary windings (A, B & C). Winding A has very low capacitance to shield, winding B has moderate capacitance to shield and moderate leakage inductance, and winding C has very low leakage inductance. All shields are connected to the frame.

FREQUENCY RANGE: below 60 cps to above 25 kcps

POWER HANDLING CAPABILITY (referred to primary):

(1) Maximum Current: 3 amps (rms)

(2) Maximum Voltage: At 60 cps, 130 volts (rms). Increases in proportion to frequency, reaching 1000 volts (rms) at 460 cps. From 460 cps to 25 kcps, 1000 volts (rms)

RANGE OF IMPEDANCE LOADS: Less than 5 ohms to above 10 K ohms.*

WINDING CHARACTERISTICS:

(1) Primary:
- *(a) d.c. resistance: less than 0.5 ohms*
- *(b) capacitance to shield: approx. 4500 pfd*

(2) Secondary winding A:
- *(a) Turns ratio (primary to secondary A); 1:1*
- *(b) d.c. resistance: less than 1 ohm*
- *(c) Capacitance to shield: Approx 300 pfd*
- *(d) Leakage inductance: 0.3 millihenries (X_{LA} approx 35 ohms at 20 kcps)*

(3) Secondary winding B:
- *(a) Turns ratio (primary to secondary B); 1:1*
- *(b) d.c. resistance: less than 0.7 ohms*
- *(c) Capacitance to shield: Approx 1500 pfd*
- *(d) Leakage inductance: 0.1 millihenries (X_{LB} approx 13 ohms at 20 kcps)*

(4) Secondary Winding C:
- *(a) Turns ratio (primary to secondary C); 2:1*
- *(b) d.c. resistance: less than 0.3 ohms*
- *(c) Capacitance to shield: Approx. 2000 pfd*
- *(d) Leakage inductance: 0.06 millihenries (X_{LC} approx 8 ohms at 20 kcps)*

FUZE: Primary Winding is fuzed with Bussman type HVB-3A. Voltage rating: 2500V (rms); Melting times: 4 amps (rms)-1 hour; 10 amps (rms)-0.01 sec; 30 amps (rms)-less than 1 millisecond.

TYPICAL LOW LEVEL FREQUENCY RESPONSES
(Without Feedback or AGC System)

Secondary Winding	*Load Resistance*	*Frequency Range for response variation less than ± 0.1 DB*	*Upper half Power Frequency (3 DB down)*
A	*1000 ohms*	*20 cps to 50 kcps*	*500 kcps*
C	*5 ohms*	*20 cps to 600 cps*	*10 kcps*
C	*30 ohms*	*20 cps to 5 kcps*	*70 kcps*
C	*100 ohms*	*20 cps to 20 kcps*	*100 kcps*

ELECTRICAL GROUND: Case, frame and shields connected together.

Mechanical

SIZE: Approx. 10½" X 11" X 9½" high (not including protective fuze and carrying handle)

PRIMARY CONNECTION: Ceramic feed-throughs, using 10 X 32 open studs for connection.

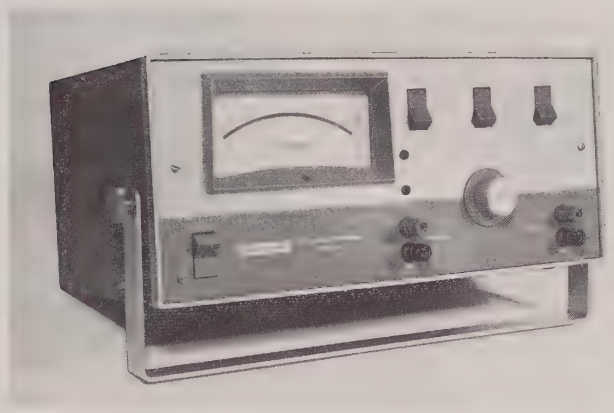
SECONDARY CONNECTIONS: Female receptacle for each secondary winding, type MS 3102A-22-8S (2 insulated pins). Mates to MS 3106A-22-8P (1 supplied).

WEIGHT: 55 pounds approx

SHIPPING WEIGHT: 75 pounds max

FUZE LOCATION: Fuze mounted on fuze block on outside of case. Electrically in series with high side of primary winding.

Completely Transistorized
BROADBAND PHASEMETER
Series 301



Featuring

- **Broad frequency range — 5cps to 500 kcps**
- **Wide dynamic range — 50 millivolts to 150 volts WITHOUT attenuation controls or plug-ins and with independent input levels***
- **Rectangular wave output for use with time measuring instruments**
- **Low impedance D. C. output for direct reading digital voltmeters, recorders or relays**
- **0° to 360° readings plus 180° phase advance**
- **Accuracy of 1° through most of range**
- **Precision 6" taut band meter**

Series 301 phasemeters have been developed for the measurement of phase difference between two sinusoidal signals. They are useful for a wide variety of applications in the audio and ultrasonic frequency range, and are particularly valuable in calibrating vibration and acoustical instruments, in measuring devices such as amplifiers, potentiometers, servo components and transformers, and in the study of vibratory and acoustical phenomena.

These instruments utilize zero crossing detection circuits to produce simultaneously a panel meter reading and a rectangular wave output for use with time interval meters. In addition, the Models 301A and 301AR produce d.c. outputs proportional to phase angle difference. The use of low noise transistors, novel circuitry and high speed flip flops provide an outstanding combination of high sensitivity and useful frequency band.

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* Units available with sensitivity to 1 mv rms

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SPECIFICATIONS

Electrical

FREQUENCY RANGE

5 hz to 500 khz.

PANEL PHASE INDICATION

6" taut band meter having illuminated mirror scales of 0-36°, 0-90°, 0-180°, 0-360°.

(Linearity better than 0.5% of full scale, add to absolute accuracy below.)

D.C. OUTPUT
(301A and 301AR only)

0 to + 3.600 volts corresponding to a phase difference of 0 to ± 360.0°

Linearity better than 0.2° (included in absolute accuracy below).

Source impedance less than 50 ohms, can be loaded with 5K Ω or higher with less than 0.1° change.

RECTANGULAR WAVE OUTPUT

1.5 volts pk-pk open circuit.

Source impedance approx. 120 ohms in series with 19 mfd.

5 nanoseconds rise time.

INPUT IMPEDANCE

100,000 ohms shunted by 10 pfd approx.

INDEPENDENT INPUT SIGNAL LEVELS*

*Low limit: 1 volt rms from 5 hz to 30 hz;** 0.3 volts at 30 hz decreasing with frequency to 50 mv at 200 hz through 50 khz, increasing with frequency to 0.5 volt at 500 khz.*

High limit: 150V rms to 100 khz, decreasing with frequency to 30 volts at 500 khz.

* Note: Model 301A(R) – 4 is available with increased sensitivity from 10 khz to 100 khz. In this frequency range, this unit will handle independent input levels between 1 mv rms and 1 volt rms, with absolute accuracy of ±1.5° above 5 mv rms, and ±3° at 1 mv rms.

** At low and high frequencies, one signal can be substantially below specified level if other signal is maintained above 1 volt rms.

ABSOLUTE ACCURACY
(with signals of independent amplitude)

Within 1° from 45 hz to 40 khz with inputs greater than 200 millivolts rms.

Within 1.5° from 7 hz to 100 khz over rated voltage range above.

Within 2° below 7 hz and from 100 khz to 200 khz.

Additional 1° for each 100 khz above 200 khz.

A.C. POWER INPUT

105-125 volts, 60-400 hz, 0.4 amps rms approx.

Mechanical

Size: Portable Models 301 and 301A, 7" high x 16½" wide x 11½" deep with carrying handle. Rackmount Models 301R and 301AR same size as Portable, except angle brackets supplied for 19" rack mounting instead of carrying handle.

Weight: Approx. 18 pounds.

Shipping Weight: Approx. 27 pounds.

SPECIALISTS IN SYNERGISTIC INSTRUMENTATION FOR ELECTRONIC, ELECTROACOUSTICAL AND ELECTROMECHANICAL MEASUREMENTS

- Complex Impedance Meters
- Nyquist Plotters
- Signal Generators
- Transfer Function Computers
- Complex Admittance Meters
- Instrument Transformers
- Sampling Voltmeters
- Plotting Paper
- Complete Acoustical Calibration Systems

Data subject to change without notice

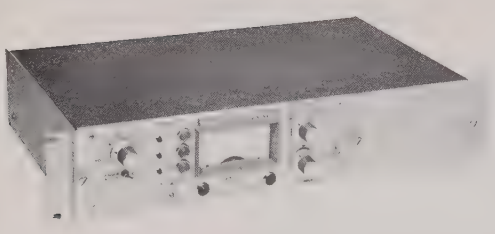
SAMPLING VOLTMETER

MODEL 215

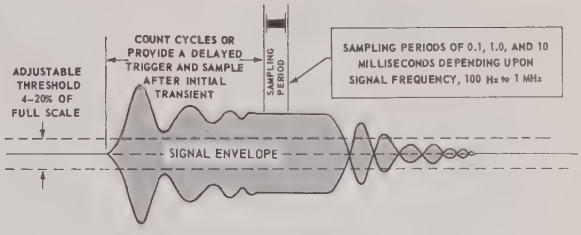
BULLETIN 215
JUNE 1968

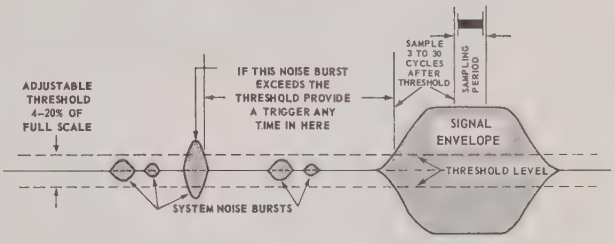
FORGET PEAK DETECTION AND STORAGE OSCILLOSCOPES!

Measure the AVERAGE Value of an AC Signal in Sampling Periods as Short as 100 Microseconds!



Model 215 in Rack Mount Configuration

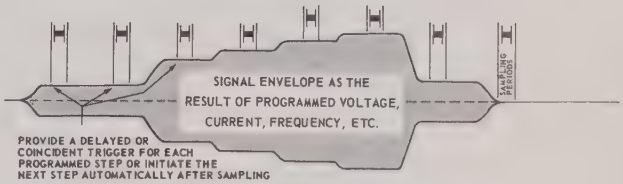

ADJUSTABLE THRESHOLD 4–20% OF FULL SCALE
COUNT CYCLES OR PROVIDE A DELAYED TRIGGER AND SAMPLE AFTER INITIAL TRANSIENT
SAMPLING PERIOD
SAMPLING PERIODS OF 0.1, 1.0, AND 10 MILLISECONDS DEPENDING UPON SIGNAL FREQUENCY, 100 Hz to 1 MHz
SIGNAL ENVELOPE

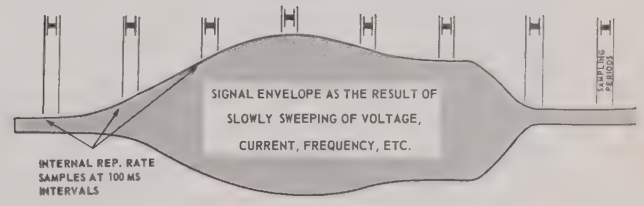

ADJUSTABLE THRESHOLD 4–20% OF FULL SCALE
IF THIS NOISE BURST EXCEEDS THE THRESHOLD PROVIDE A TRIGGER ANY TIME IN HERE
SAMPLE 3 TO 30 CYCLES AFTER THRESHOLD
SAMPLING PERIOD
SIGNAL ENVELOPE
THRESHOLD LEVEL
SYSTEM NOISE BURSTS

- Frequency – 100 Hz to 1 mHz
- Sample and hold output – panel meter and DC outputs
- For single or repetitive measurements up to 1000 samples per second.
- Output independent of sampling time or duty cycle
- For use up to 5000 V rms and 50 AMPS rms with commercially available current and voltage probes.

The Model 215 Sampling Voltmeter is designed to measure the amplitude of a sinusoidal signal during a short sampling period, producing a D.C. output voltage and a direct front panel meter reading.

Based on an AVERAGING, rather than peak detection system, the Model 215 minimizes the effects of spikes and other noise which may be present in the signal. Yet, its unique design features very short sampling times (as short as one cycle) as well as unusual simplicity and compatibility with commercially available equipment.


SIGNAL ENVELOPE AS THE RESULT OF PROGRAMMED VOLTAGE, CURRENT, FREQUENCY, ETC.
SAMPLING PERIODS
PROVIDE A DELAYED OR COINCIDENT TRIGGER FOR EACH PROGRAMMED STEP OR INITIATE THE NEXT STEP AUTOMATICALLY AFTER SAMPLING


SIGNAL ENVELOPE AS THE RESULT OF SLOWLY SWEEPING OF VOLTAGE, CURRENT, FREQUENCY, ETC.
SAMPLING PERIODS
INTERNAL REP. RATE SAMPLES AT 100 MS INTERVALS

Typical applications include: (1) high speed component testing; (2) analysis of time-varying or transient effects; (3) measurement of direct or reflected acoustical signals; and (4) measurement and control (with 501 Servo Control Unit) of signal burst levels applied to radiators or receivers.

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Patent Pending

DRANETZ
ENGINEERING
LABORATORIES
INCORPORATED

1233 NORTH AVENUE, PLAINFIELD, N. J. 07062 • TEL (201) 755-7080

SPECIFICATIONS

Signal Frequency Range:
100Hz to 1mHz

Signal Input Impedance:
Approx. 1 megohm shunted by 50 pf

Input Signal Levels:
6 full scale ranges of 0.1 to 5 volts rms fs without external probes. Typical recommended probes: Tektronics P6006 (1–50V rms); Tektronics P6007 (10–500V rms); Tektronics P6013 (100–5000V rms); Dranetz TR2004 (1–50A rms); Dranetz TR2005 (0.1–5A rms). Threshold, adjustable 4–20% fs.

Input Circuit Configurations:
Single ended, floating ground
Differential

Repetition Rate:
For CW: Internal generator, approximately 10 samples/second
For Gated CW: (1) w/out internal delay, 1 sample per 2.5 sec. to 1000 samples per second
(2) with internal delay, minimum of 10 ms off time required between pulses
Trigger Input (to initiate sampling): square wave, pulse, or step, ± 5 volts peak, rise time < 50 microsec. 10–90% transformer input ungrounded, input impedance approx. 5k ohms shunted by 100 pf.
Single Shot: Hold time up to 2 minutes

Sampling Period:
Automatic sampling period selection with manual override. Periods approx. 0.1, 1, and 10 ms. Requires minimum of 1 full cycle.

Delay Control to Mask Signal Transients:
External: Controlled by external trigger input
Internal: Below 0.5 mHz, selectable cycle count 3 to 30 cycles; above 0.5 mHz, selectable time delay of 6 to 60 microsec.

Accuracy:
± 2% of reading ± ½% fs for single ended input

Output Indication:
Linear scale panel meter, direct reading, calibrated in rms units, D.C. output, 0 to 5 volts full scale, 600 ohm output impedance to drive >10k ohms load (calibration means provided for load correction)

Sample and Hold Facility:
Output hold circuit is transferred to each computed level after sampling and computation. No "discharge and reset" action between readings.

Monitor and Control Outputs:
(1) Synchronizing pulse for external equipment (e.g., for printers, recorders, 501 Servo Control Unit)
(2) Monitor Output: Signal, approx. 2v pk-pk, with 0.5 volt pedestal indicating sampling time.

Visual Indicators:
For overload, correct sampling, and sampling period

Compatibility:
Compatible with Dranetz Tone Burst/Timing Generator 206, and other pulse generators

AC Input Power:
115v, 50–60Hz, 18 watts

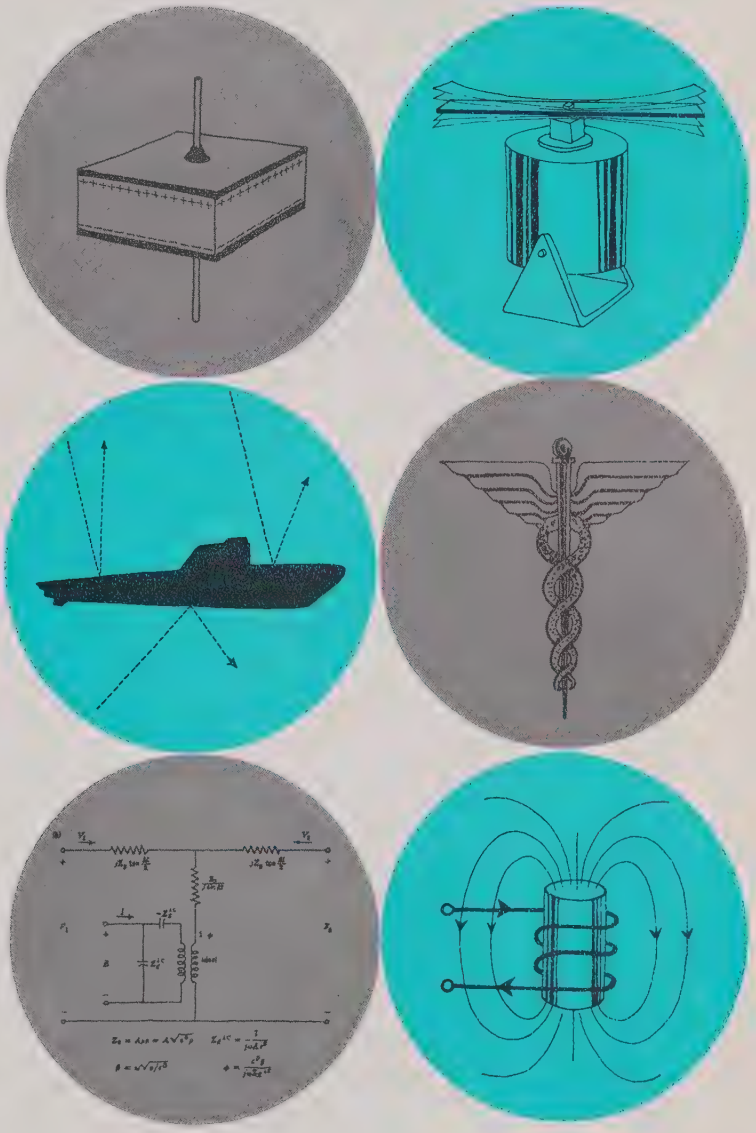
Size:
In case: 12" wide x 4" high x 13" deep. For rack, mounts in Dranetz MR11 rack cabinet (3½" high x 19" rack x 13" deep) utilizing 2/3 front panel space

Weight:
16 pounds

Shipping Weight:
25 pounds

BULLETIN 100

Revised April, 1969



COMPLEX IMPEDANCE, ADMITTANCE, AND TRANSFER FUNCTION MEASUREMENTS

DRANETZ

APPLICATIONS

Materials Research
- Dielectric properties
- Magnetic parameters
- Conductivity measurements
- Electromechanical coupling

Electroacoustical Transducers
- Resonance frequencies
- Mechanical and electrical Q
- Coupling coefficient
- Potential efficiency
- Complex immittance plots

Electrical Components
- Antenna testing
- Rapid testing of resistors, inductors, capacitors, crystals and transformers
- Measurement of quality factor Q
- Non-linear analysis

Active and Passive Networks
- Input impedance
- Output impedance
- Transfer function — Bode and Nyquist plots
- Open and closed loop parameters

Mechanical and Acoustical Systems
- Radiation load measurements
- Comparison of motional characteristics of two spacially separated points
- Mechanical or acoustical impedance and mobility

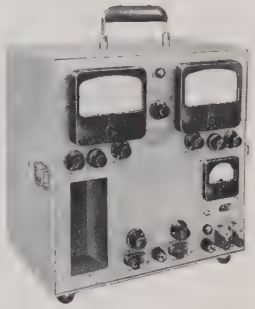
Impedance Studies in Physiology
- Tissue, muscle, nerve and bone parameters
- Electrode characteristics
- Impedance plethysmography
- Electrochemical measurements

Dranetz 100 series Complex Impedance-Admittance Meters comprise a family of integrated instruments for the direct measurement of the vector components of impedance, admittance, transfer function, and power as well as vector voltage and phase angle.

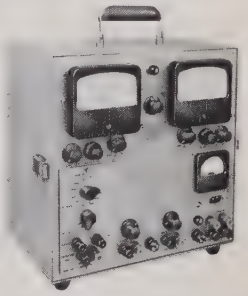
For any application a combination of two instruments is used — a main frame unit and a plug-in or adapter. The main frame unit (Models 100B, 100B Mod. 4 and 100C) is capable of analyzing a sinusoidal AC voltage, producing panel meter readings and DC outputs proportional to in-phase and quadrature components of this voltage (using a second sinusoidal signal as a phase reference). The plug-in or adapter unit (Model 100-PA-[—]) controls the AC current or voltage applied to the unknown, measures the resultant voltage or current, and after proper scaling, applies these signals to the main frame unit for computation and direct readout. For example, the adapter may be designed for direct measurement (i.e., without bridge balancing) of two termial impedance or admittance at low or high power levels, the vector difference between two admittances or impedances, electrical capacitance and dielectric loss, or four terminal characteristics such as transfer function.

While designed principally for CW type measurements, the 100 series Main Frames can be used under limited gated CW conditions, wherein the duty period is sufficiently long. For a wide range of pulse applications, however, the Dranetz type 202 Vector Component Computer is available. With this instrument, 100-PA series and other plug-ins or adapters can be used for CW or gated CW measurements.

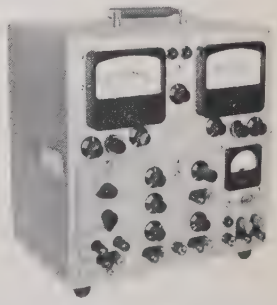
3 BASIC MAIN FRAMES



Model 100B — Measures in-phase and quadrature components of Z, Y and transfer function

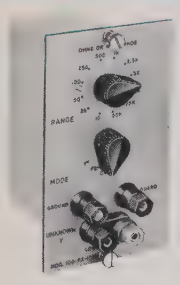


Model 100B-Mod 4 — Similar to 100B but includes internal emitter follower of higher power capability (Shown with plug-in 100-PA-1001A)



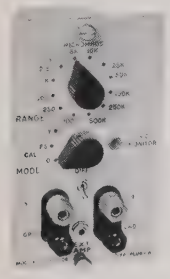
Model 100C — Measures in-phase and quadrature components, as well as amplitude and angle of Z, Y and transfer function. Has higher power emitter follower and system for balancing external hum.(Shown with plug-in 100-PA-1001A)

TYPICAL PLUG-INS AND ADAPTERS



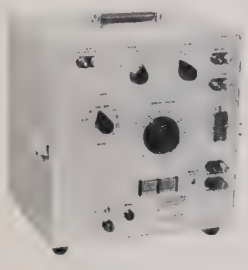
100-PA-1001A
General Purpose
Impedance-Admittance Plug-in

100-PA-1004
Low Impedance
Plug-in



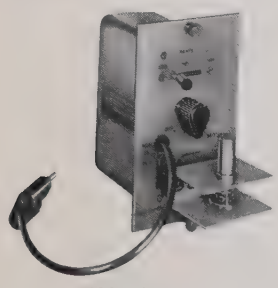
100-PA-1008
Differential Admittance Plug-in

100-PA-1009
Differential Admittance Plug-in



100-PA-1010A
High Power Impedance Adapter

100-PA-1011B
High Power Admittance Adapter



100-PA-1012A
Piezoelectric Activity Plug-in

100-PA-1013
Transfer Function Plug-in

RAPID MEASUREMENTS

The ability of these instruments to provide direct and rapid readings *without bridge balance* has, in a number of cases, produced savings equivalent to the total cost of the equipment within the first four months of use. With an X-Y recorder or oscilloscope, these instruments can plot a complete multiloop complex plane impedance locus of an electroacoustical transducer in 20 seconds — a task that might take up to four hours using a conventional bridge. In addition, these instruments can be used with GO-NO-GO indicators for rapid production testing or sorting of electronic components.

EXCEPTIONAL VERSATILITY

The broad scope of available plug-ins and adapters provides a wide variety of different measurements under such diverse conditions as high, low, and variable power as well as grounded or ungrounded connections, with the ability to reduce or eliminate the effects of cable loading by the use of driven shield or subtraction techniques. Hybrid bridge plug-ins can be used to combine high speed and high accuracy for production testing of electronic components. With an ever-increasing number of available general purpose and special purpose plug-ins, these instruments will truly appreciate rather than depreciate in value with passing time and use.

BUILT-IN DEPENDABILITY

These instruments incorporate many unusual features to insure ease of use, reliability and minimum down time. Synchronous detection and hum balance provisions (Model 100C) are used to remove effects of 60 cycle pickup, as well as ripple and nonsynchronous signals which may exist across, or be generated by, the unknown. An overload detection system prevents false readings and gives an immediate indication of scale underranging. Main frame units are completely transistorized, with all active circuits packaged in plug-in modules for reliability, ease in maintenance and simple replacement. Packaged in portable carrying cases and available with spare plug-in modules, these instruments have had an outstanding record of performance and reliability not only in laboratories within the continental U.S., but as well aboard Navy and oceanographic vessels, and in laboratories throughout the western world.

Various instruments described herein are covered by the following U.S. Letters of Patent: 3,275,933, 3,267,355, other pat pend.

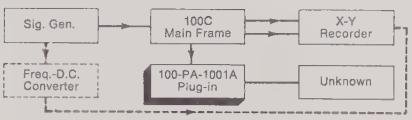
PLUG-INS AND ADAPTER UNITS

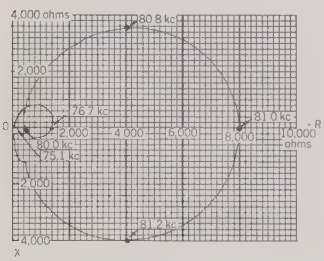
Series 100 Main Frames are designed to accommodate an ever-increasing number of plug-ins and adapters. Typical of devices currently available are those described herein, for which complete performance specifications are given.[1] In addition to these, blank plug-ins are available and special units can be engineered to solve specific problems. For all standard plug-ins and adapters, full scale ranges are set up in 1, 2.5, 5, and 10 etc. sequence, with compatible scales on the Main Frame meters. By use of this scale sequence and an internal calibration standard, recordings on any decade rectalinear graph paper are provided with direct coordinate calibrations for all ranges.

100-PA-1001A, General Purpose Impedance-Admittance Plug-in

This unit provides for a wide range of two terminal impedance and admittance measurements over the entire frequency range of the Main Frames. For all measurements the unit is plugged directly into the front panel of the Main Frame, utilizing frame DC power and AC signal (external generator required).

Measurement of complex impedance is made by applying constant current to the unknown and feeding the voltage developed across the unknown (45 mv maximum[2] proportional to percent scale reading) into the Main Frame unit, which generates DC outputs proportional to equivalent series resistance and reactance. In this measurement one terminal of the unknown is grounded. Complex admittance is measured by applying three volts across the unknown, and measuring current, which is analyzed in the Main Frame, producing DC outputs proportional to parallel conductance and susceptance. In this measurement, neither terminal of the unknown is grounded. At 159 kHz inductance (in μh) may be read directly from the impedance scale, and capacitance (in pfd) may be read directly from the admittance scale. Frequencies of 0.159, 1.59 and 15.9 kHz can also be used for direct measurement of inductance and capacitance. The plug-in contains a single Range switch having twelve ranges in ohms or micromhos.





The block diagram illustrates a typical instrument arrangement[3] for plotting impedance or admittance curves on a complex plane, using the 100-PA-1001A. This arrangement is particularly well suited for plotting X vs R, B vs G, or X, R, B, Y, Z or θ vs frequency.

Complex Impedance plane plot of piezoelectric ceramic disk. (Plotted on X-Y recorder in 20 seconds.)

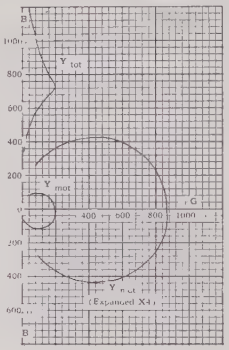
100-PA-1004, Low Impedance Plug-in

Similar in design to the impedometer circuit of the 100-PA-1001A, this unit extends direct impedance measurements to considerably below 1 ohm (12 full scales from 1 to 5,000 ohms) over the full frequency range. Particular care has been taken in reducing series residual resistance ($<$ 0.015 Ω) and inductance ($<$ 0.15 microhenries). Furthermore, by short circuiting the test terminals, even this small residual can be easily and accurately measured and subtracted from test readings.

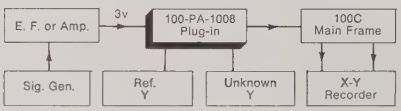
100-PA-1008, Differential Admittance Plug-in

This instrument is designed for measuring admittance or admittance difference. For transducer analysis this unit can provide not only a plot of the total admittance locus, but also a plot of the motional admittance locus by subtraction of the clamped admittance.[4] This is particularly valuable for loaded transducers where, because of low mechanical Q, the motional admittance characteristics are often hidden by the clamped parameters. This difference measuring unit also rapidly determines the minor component of admittance with substantially improved accuracy, eliminating the need for bridges for this purpose. The ease of operation and rapidity of measurement of this system also makes this unit ideal for use as a deviation indicator for incoming inspection or production testing of components or sub-assemblies. Features include 12 ranges of admittance up to 500m $\mho$ and capability of handling grounded unknowns.

This unit applies a 3 volt signal across both admittances and produces an output signal having phase and amplitude dependent on the difference in currents through the two admittances. The output signal is fed to the Main Frame of the Complex impedance-Admittance Meter which provides direct meter readings and DC outputs equivalent to difference parallel conductance and susceptance. A typical instrument arrangement for differential admittance measurement is shown below.



Complex admittance plane locus plots of a low Q transducer. Clamped admittance has been subtracted from total admittance to plot motional locus.



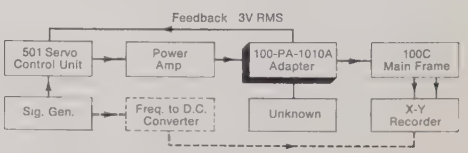
100-PA-1009 Differential Admittance Plug-in

This plug-in measures extremely small admittances or admittance differences up to 10 kHz. Having 12 ranges with scale expansions by factors of 10 and 100, this instrument provides full scale ranges of admittances to 0.025 micromhos. Thus it is extremely useful for direct indication or changes in capacitance and dielectric dissipation factor of two terminal devices. For example, full scale readings correspond to dissipation factors as low as 0.01. In addition, the sensitivity is so high that at 10 kHz the instrument will easily read changes of less than 0.02 pfd. The equipment arrangement is similar to that shown above for the 100-PA-1008.

100-PA-1010A, High Power Impedance Adapter

With series 100 Main Frames, this instrument provides a direct measurement of series resistance, series reactance, impedance amplitude and phase, as well as real, imaginary and vector power at both low and high levels of voltage and current applied to the unknown up to 31 Amps, 3.1 KV. This is accomplished by a current and voltage scaling system having dual channels which track precisely in amplitude and phase throughtout a wide range of attenuation and/or gain[5] and over broad frequency range (up to 75 kHz).

Connected typically as in the block diagram below, this unit can be used for automatic plotting of impedance as a function of frequency or of signal level. In the frequency plot, the Servo Control Unit is used to maintain constant current into the unknown while the frequency is varied. Resistance versus reactance may be plotted directly on the X-Y recorder. Using the external frequency to DC converter, plots of resistance, reactance, total impedance and phase may



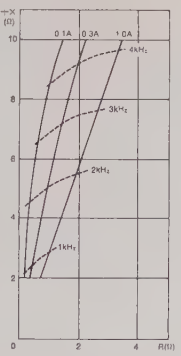
FOOTNOTES

(1) In the applications of plug-ins and adapters discussed in this bulletin, use with the 100C Main Frame is presented by example. Model 100B or 100B Mod. 4 Main Frames can also be used interchangeably, except, of course, that the amplitude-phase display mode is not available.

(2) Except where otherwise noted, all reference to volts or amps are in RMS units.

also be plotted as a function of frequency.

At any fixed frequency in the range of the adapter, the impedance may also be plotted automatically as a function of applied current level. Utilizing the DC outputs of the Main Frame and adapter (DC output proportional to signal level), curves of resistance versus reactance, or resistance, reactance, impedance amplitude and angle versus current may be made in seconds on an X-Y recorder. Herein are shown complex plane impedance plots taken on a non-linear inductor at various levels of input current. While this instrument was designed for direct measurement of single ended unknowns, it can also be applied for measurements of balanced loads.



Complex impedance loci of non-linear inductor (core material: grain oriented 3.5% silicon-iron) at various levels of current. Curves show increasing loss and decreasing permeability with increasing frequency, and also increasing loss and increasing permeability with increasing current.

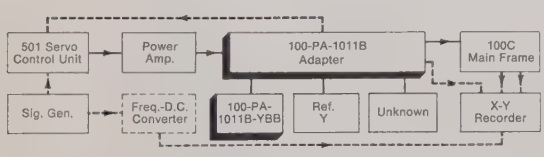
This instrument is particularly useful in testing sonar and ultrasonic transducers, transformers, loudspeakers and chokes. Outputs are available for AC current and voltage monitor as well as for use with the Model 501 Servo Control Unit. Because of the high signal levels accommodated, particular attention has been given to incorporation of safety features such as over-current and over-voltage cutoffs in addition to the use of rear panel connections.

100-PA-1011B, High Power Admittance Adapter

One of the most versatile of the 100-PA-[——] adapters, this instrument is capable of making either direct or differential admittance or capacitance measurements (as well as real, imaginary and vector power) at any value of applied voltage between 6 and 6000 volts rms at frequencies up to 75 kHz. As in the case of the 100-PA-1010A, this is accomplished by scaling both current and voltage signals in channels which track each other precisely in amplitude and phase.

In order to provide maximum versatility, this instrument has its own front panel cutout to accommodate three types of plug-ins — a Broad Band Admittance Plug-in (Model 100-PA-1011B-YBB), a series of Scale Expansion Admittance ÷10 and ÷100) Plug-ins (Model 100-PA-1011B-Y[——]) for use over limited frequency ranges, and a series of Capacitance Plug-ins (Model 100-PA-1011B-C[——]) which provide for direct readings of capacitance and electrical dissipation factor at a single frequency. (e.g. 500 Hz, 1000 Hz)

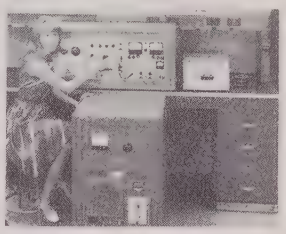
Used with the Broad Band Admittance Plug-in (-YBB) as shown in the block diagram below, this adapter is capable of providing an immediate plot of admittance or admittance difference (G vs B; or G, B, Y or θ vs frequency) as the frequency is varied, using the Model 501 Servo Control Unit to maintain constant voltage (the 501 may not be required if the power amplifier has sufficient capacity and load regulation). In addition, at any frequency in the band, this system may be used to provide a scan of admittance as a function of applied voltage level. (A DC output voltage, proportional to the AC voltage across the unknown, is provided on the rear of the adapter for feeding the X axis of the recorder.)



The use of differential measurements is particularly effective in (1) separating motional admittance circles from total admittance, (2) improving accuracy of the minor component, and (3) observing small deviations from a reference standard as a function of level.

With the 100-PA-1011B-YBB Plug-in, the lowest full scales of the instrument are 1000$\mu\upsilon$ between 6 and 60V, 100$\mu\upsilon$ between 60 and 600V, and 10$\mu\upsilon$ between 600 and 6000V. For measuring lower admittance or admittance differences this plug-in may be replaced by a Scale Expansion Admittance Plug-in custom engineered for the frequency of use.

For rapid and accurate measurements of capacitance and dissipation factor at a fixed frequency, a Capacitance Plug-in is used and the Y_{REF} is replaced by a calibrated low loss capacitor (such as the Dranetz Model N113A, 10,000 pfd max. or N115, 0.08 mfd max). With this arrangement the equipment provides direct or deviation readings of capacitance and dissipation (in percent or pfd). Typical of a complete Dielectric Test System is the Model S-3 (shown in the photograph below), designed for testing electrostrictive ceramic elements at high field strengths. Consisting of a floor mounted signal source and bench top instrument assembly, this system is capable of testing up to 6KV at 1 kHz with a maximum vector power of 1KVA (power limit of signal source) into the capacitor under test. For providing a direct and rapid plot of capacitance or dissipation versus voltage level, the Model 501 Servo Control Unit is added to this system.



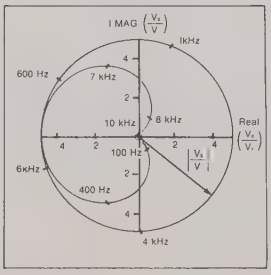
Model S-3 Dielectric Test System, for measurement of dielectric constant and dissipation at high electric fields (Photo courtesy of General Electric Co.)

100-PA-1012A, Piezoelectric Activity Plug-in

This instrument is a special purpose unit designed principally for rapid production measurement of resonance and anti-resonance frequencies as well as mechanical Q on high Q (up to 600 or higher) piezoelectric elements. It has three fixed ranges of admittance — 25$\mu\upsilon$, 2.5mυ and 250mυ full scale, selectable by a simple lever switch — in order to display the locus near both the resonance and anti-resonance for measuring the critical frequencies and mechanical Q within the range of 100 kHz to 300 kHz. Other frequency and admittance ranges can be supplied on order.

100-PA-1013, Transfer Function Plug-in

This plug-in, which fits directly into the 100 series Main Frame, is used for transfer function measurements on four terminal networks (with common ground). Having 16 ranges, this unit accommodates devices having voltage gains substantially less than 0.1 to more than 10,000. With this device, the panel meters (and DC outputs) on the 100 series Main Frames are directly calibrated in output-to-input voltage ratio, presenting either the two components of the vector ratio or the vector amplitude ratio and phase angle difference. Low source impedance and high measuring impedance are featured, to accommodate a broad range of impedance levels of the circuit under test. Both complex plane (Nyquist) and frequency (Bode) plots are possible, using an X-Y or strip chart recorder.



Locus of complex transfer voltage ratio for a passive band-pass filter (400-7000Hz). Vertical component is imaginary and horizontal component is real part of output-to-input ratio.

(3) Note: Optional instruments shown in dashed lines.

(4) A. I. Dranetz and H. L. Rathbun, "Analysis of Electroacoustical Transducers by Differential Immittance Techniques." J. Acoust. Soc. Am., Vol. 40, No. 2, 412-416 (1966).

(5) A. I. Dranetz and I. Backinoff, "Recording Impedance and Admittance of Transducers under High Power." Electronic Products Magazine, May 1965 (reprinted by Dranetz Engr. Labs, Inc. as Tech. #1).

SPECIFICATIONS
MAIN FRAME UNITS

Model	Data Presentation	Frequency Range	Internal Purpose
100B 100B Mod. 4	Two 4″ panel meters calibrated in in-phase and quadrature units. Two DC outputs proportional to in-phase and quadrature components (0.7 V FS min.)	100 Hz to 200 kHz (can be extended on special order)	Drives impedometer-admittometer circuits of certain plug-ins, eliminating need for external amplifier, or other low impedance source (see "Signal Power Required" column in Plug-in data below): Input z > 10K Ω.
100C	In component display mode, same as above. In amplitude-angle display mode, meters and DC outputs represent amplitude and phase.	In component display mode, 100 Hz to 200 kHz. In amplitude-angle display mode, 100 Hz to 100 kHz.	

Output filters (each DC output): With panel switch in NORMAL, rise time (0-90%) approx. 200ms. With panel switch in FAST, rise time approximately 30ms.

Output Scaler (each DC output): Front panel switches provide independent attenuation of X and Y outputs to 0%, 50% and 100% for convenience in setting up X-Y recorder.

PLUG-IN AND ADAPTERS

Model 100-PA-	Description	Freq. Range	Linear Ranges, Full Scale 1, 2.5, 5, etc. sequence	Signal Power Required	Voltage Across or Current Through Unknown
1001A	General Purpose Plug-in	100 Hz to 200 kHz	12 Z and 12 Y Ranges 10Ω to 50 kΩ 10μ℧ to 50 k℧	Ext. sig. gen., single ended, 3V, into Main Frame (Z_{in} > 10KΩ). For Y greater than load limit above, use low impedance source to drive unknown directly.	0-45mv in Z mode 3V in Y mode
1004	Low Impedance Plug-in	100 Hz to 200 kHz	12 Z Ranges 1Ω to 5kΩ	Ext. osc. 3v into Main Frame (Zin = 10 kΩ). For FS ranges below load limit of Main Frame, use Pwr. Amp.	0-45mv
1008	Differential Admittance Plug-in	100 Hz to 100 kHz	12 Y Ranges 100μ℧ to 500m℧	Ext. sig. gen., single ended, 3V, low impedance source required for all measurements. Source must be capable of driving unknown and reference Y in parallel.	3V across both unknown Y and reference Y
1009	Differential Admittance Plug-in	100 Hz to 10 kHz	12 Y Ranges, 2.5μ℧ to 10 k℧, plus scale expansions of X0.1 and X.01 for diff Y.	Ext. osc. 3v into main frame (Zin = 10k℧) for Y loads above load limit of main frame emitter follower, source must be capable of driving unknown and reference Y in parallel.	3V across both unknown Y and reference Y
1010A	High Power Impedance Adapter	100 Hz to 75 kHz	13 Z Ranges 1Ω to 10kΩ	Ext. generator, single ended, low impedance source required for all measurements. Source must be capable of driving unknown directly at test level.	Any value of current between 0.0316 and 31.6 amps. with maximum voltage of 3.16KV.
1011B	High Power Admittance Adapter	100 Hz to 75 kHz	12 Y(μ℧) and C(pfd) Ranges 1K to 10^6, <60V 100 to 10^5, 60-600V 10 to 10^5, >600V	Ext. generator, single ended, low impedance source required for all measurements. Source must be capable of driving unknown and reference Y in parallel at test level.	6 to 6000V, total current not to exceed 31.6 amps. Higher current possible with external current transformer
1012A	Piezo-Activity Plug-in	100 kHz to 300 kHz	3 Y Ranges 25μ℧, 2.5m ℧, 250m℧	Ext. sig. gen., single ended, low impedance source required for all measurements. Source must be capable of driving unknown at 3V.	3V
1013	Transfer Function Plug-in	100 Hz to 200 kHz	16 Gain Ranges ×0.1 to ×10,000	Ext. osc., 3V into Main Frame, Z>10KΩ, all ranges.	Input: 0.3 to 300mv Output: 3mv to 30V (Dependent on gain)

Plug-in units: (except 100-PA-1009) size 3½″ x 6″ x 4″; weight, actual 3#, shipping 6#; electrical power, DC from Main Frame, 100-PA-1009, 4½″ x 6″ x 10″ (extends 6″ in front of main frame panel)

Adapter units: 14″ x 13″ x 13″; weight, actual 52#, shipping 85#; electrical power, 105-125V, 60 Hz, 60 W; 19″ Rack mounting adapter, Model MR10 available (see above)

Note: All values of current and voltage specified are in rms units.

Emitter Follower / Load Limit	Hum Balance	Electrical Power	Weight (lbs.) Carrying	Weight (lbs.) Shipping
For Z meas., 5 Ω min. FS range For Y meas., 2.5m ℧ max. admittance	None	105-125V, 60 Hz 25 watts max.	27	46
For Z measurement, 1 Ω min. FS range For Y measurement, 25m ℧ max. admittance	Provides for injection of internal 60Hz with amplitude and phase controls on front panel. Other frequencies (100-1000 Hz) can be injected from external source having its own phase shift control.	105-125V 60 Hz 50 watts max.	30 35	49 56

Construction: Circuits individually packaged in plug-in modules for ease in maintenance. Units are completely transistorized. Units packaged in aluminum carrying cases 13" x 13" x 13½" maximum including cover.

Rack mount adapters (19" x 15¾" high) available for mounting all 100 Series Main Frames. Specify model MR 10.

Test Terminal Configuration	ACCURACY (REF. RECONSTRUCTED VECTOR) Specs are for unit in 100B, 100B-Mod 4, 202 (A), or 100C Main Frame in Component Display Mode*	Remarks
Two 5 way terminals for Z and Y. Z mode: LO side ckt. gnd. Y mode: both off gnd.	For impedance: ±2% FS, ±2½° plus effect of residuals (Ls < 0.1μh, Cp < 15 pf) For admittance: ±2% FS, ±2½° up to 100 kHz up to 10 kμ℧. For higher ranges add following effects of residuals: Amplitude, 4 fY x 10^{3}% Phase, 8 fY x 10^{-5} degrees; where f = freq. in kHz, Y = full scale range setting in kμ℧.	Broadest range of applications. Recommended for general use with Main Frame.
Two 5 way terminals. LO side ckt. gnd.	Amplitude: Better than ±2% FS to 200 kHz. Phase: Better than ±2½° to 150 kHz ±5° to 200 kHz. Above 50 kHz add effects of residuals below. Residual: Series R < 0.015Ω, L < 0.15 microhenries. Parallel cap. 10 pfd. approx.	
Two pairs 5 way terminals Both LO terminals at ckt. gnd.	Better than ±2% FS, ±2½° plus residuals over the following: 0.1 to 0.25 kHz — scales of 0.5 to 500m ℧ 0.25 to 5 kHz — scales of 0.1 to 250m ℧ 5 to 50 kHz — scales of 0.1 to 100m ℧ 50-100 kHz — scales of 0.1 to 50m ℧ Residuals Rs <0.1Ω, Ls <3μh	Differential measurements can improve accuracy to limit imposed by common mode error. Common mode error of unit is better than 50 db for $Y_X = Y_{REF}$ = 1 to 100m ℧ between 1 kHz and 20 kHz
Two pairs 5 way terminals Both LO terminals at ckt. gnd.	Direct Y: ±2% Amplitude, ±2½° for Y ≧ 10 kμ℧. Expanded Ranges (Diff Y): Major component and minor component (after major component balance) having following accuracies ref. FS from 200 Hz to 10 kHz for ranges > 10μ℧, from 200 Hz to 5 kHz for 10μ℧ range, and from 200 Hz to 1 kHz for ranges < 10μ℧: exp. X0.1: ± 0.5%; exp. X0.01: ±0.1%. Residual: < ±0.01μ℧ in quadrature and in-phase.	Particularly useful for low admittances and in the rapid measurement of capacitance & dissipation factor.
High voltage coaxial connector in rear Shell is at ckt. gnd.	Max. AMPS. / 100 Hz to stated freq. for error < shown**: 2% FS, 2½° φ / 3% FS, 3½° φ / 5% FS, 5° φ 3.16: 50 kHz / — / — 10: 30 kHz / 40 kHz / 50 kHz 31.6: 20 kHz / 22 kHz / 25 kHz	Accessories: Z range extender, low level isolation transformer, interconnection unit For automatic plotting, AGC (Model 501) necessary to maintain constant current
Hi voltage coax. connectors in rear for unknown Y and reference Y. Shells at ckt. gnd.	Amplitude: Error < ±2% FS ±1% reading up to 50 kHz Phase: Error < ±2½° up to 25 kHz (except ±3° on 100μ℧ range at 100 Hz); less than ±3½° at 50 kHz. Residuals: Cp ≈ ±10 pf, Ls ≈ 5μh.	Accessories: similar to those of 100-PA-1010A. Automatic plotting may require AGC (Model 501). Specify front panel plug-in required for the specific application.
Two 5 way terminals. Both off gnd.	Amplitude: Error <3% FS Phase: Error <4°	For rapid production testing of High Q elements. Requires special main frame for high frequency. Special units available for individual applications.
Two pairs 5 way terminals Both LO terminals at ckt. gnd.	Amplitude: Better than ±2% FS to 150 kHz Better than ±4% FS up to 200 kHz Phase: Better than ±2½° to 150 kHz. Better than ±7° up to 200 kHz Residual: Capacitance approx. 30 pfd across output of test circuit.	Source Z into Unknown 10-40Ω Input Z from Unknown 500 kΩ, 30 pfd

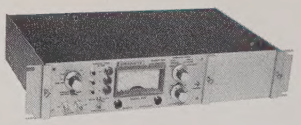
** In addition, shunt cap of approx. 30 pfd across unknown.
Note: Cap residuals are in parallel with unknown; R and L residuals are in series.
These specifications supersede all prior specifications

*When the 100C is used in the amplitude-angle display mode, an additional error of 1% FS amplitude and 3° phase is produced when frequency is between 75 kHz and 100 kHz

OTHER RELATED PRODUCTS

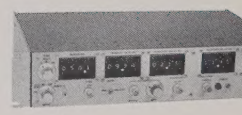
Sampling AC Voltmeters

- Measure the average value of an AC signal during sampling periods as short as 100 microseconds.
- Frequency range: 100 Hz to 1 MHz.
- Available with linear or logarithmic DC outputs — up to 80 DB dynamic range.
- Sample and hold outputs; externally programmable for automatic test systems.



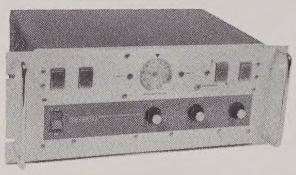
Digital Gating/Timing Generator Series 206

- Produces zero crossing turn-on turn-off of AC signals (single or repetitive gating).
- Provides additional timing for controlling gated detectors or receivers.
- All timing digitally controlled — from front panel or from BCD inputs at rear.
- Frequency range: 50 Hz to 3 MHz.



Servo Control Unit Model 501

Electromechanical servo designed for insertion between signal generator and power amplifier to control the level of an electrical signal. Can be used directly for holding constant level of AC or DC current or voltage. With peak detecting unit, can be used for pulse; with programmer, can be used to follow programmed levels.



Pulse Measuring Systems

Major instruments and complete systems for calibrating electroacoustical transducers, including transmission response, complex impedance and admittance, phase angle and power under low and high levels. Pulse times from less than 1 ms; frequency range, $<$ 50 Hz to $>$ 1 MHz.

Vector Component Computer M 202A to measure in-phase and rature components as well as a tude and phase of a CW or CW signal. Integrating techniq duces the effects of noise, ha ics, and uncorrelated frequen

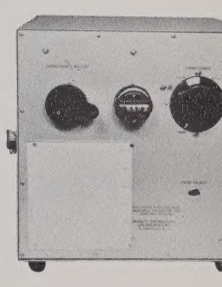
Display Converter Unit Model 505

A coordinate converter for extending the flexibility and usefulness of standard X-Y recorders to plot frequency response, Nyquist diagrams, complex immittance, transmission response, and polar beam patterns. Particularly useful in antenna test systems, electroacoustical transducer testing and network analysis.

High Voltage Capacitors

Continuously variable and decade capacitors for bridges and other precision applications:

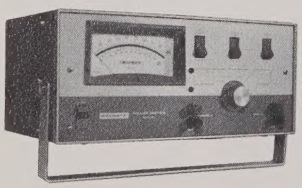
- Model N113A, variable to 0.01 mfd
- Model N115, decade to 0.08 mfd
- High voltage — 10,000 volts peak
- Low loss — less than 0.0008 at 1 kHz



Broadband Phasemeter

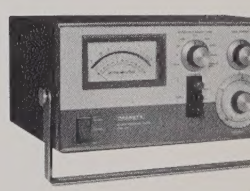
Excellent general and special purpose instrument for all electrical or electroacoustical laboratories

- Completely transistorized
- Frequency range of 5 Hz to 500 kHz
- Input levels: 50 mv to 150 V rms, independent amplitudes, no attenuator controls
- DC output
- 0.1° accuracy over most of range



Impedance Amplitude Meter Series 320

- Measures magnitude at impedance and transfer function
- AC outputs for 301 phasemeter to measure vector phase
- 5 Hz to 500 kHz
- 1Ω to 10 megΩ; 0.1 pfd to 10,000 mfd; 1 μh to 100,000 h
- DC outputs
- Low in cost



Data subject to change without notice.

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